

APPENDIX D

Robustness of VSL Estimates from Contingent Valuation Studies

By Anna Alberini

ROBUSTNESS OF VSL ESTIMATES FROM CONTINGENT VALUATION STUDIES

by

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**WILLINGNESS TO PAY FOR MORTALITY RISK REDUCTIONS:
THE ROBUSTNESS OF VSL FIGURES FROM CONTINGENT VALUATION STUDIES**

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1. INTRODUCTION

Reductions in risk of death are arguably the most important benefit underlying many health, safety, and environmental legislative mandates. For example, in two recent analyses of the benefits of U.S. air quality legislation, *The Benefits and Cost of the Clean Air Act, 1970-1990* (US EPA, 1997) and *The Benefits and Cost of the Clean Air Act, 1990-2010* (US EPA, 1999), over 80 percent of monetized benefits were attributed to reductions in premature mortality.

In quantifying the benefits of policies that save lives, Viscusi (1993) recommends a range of Values of a Statistical Life (VSLs) from \$3 to 7 million (1990 dollars) based on a review of labor market and other studies. The US Environmental Protection Agency (USEPA) uses a VSL of \$6.1 million (1999 \$) in its base analyses.¹ This value was derived by the Agency using values from 26 studies of mortality risk valuation. The majority of these studies are compensating wage studies that use observed workplace risk-income tradeoffs to infer the VSL. Only five of the twenty-six estimates are from stated-preference studies that elicit directly willingness to pay for a specified risk reduction (Gerking et al., 1988; Jones-Lee et al., 1985; Miller and Guria, 1991; Gegax et al. 1985) or risk-risk and risk-dollar tradeoffs using a variant of conjoint questions (Viscusi et al., 1991a).

These contingent valuation (CV) studies, however, are broader in scope than hedonic wage studies, in that the risks they value are not limited to workplace risks. Moreover, in principle the method of contingent valuation offers greater flexibility than other approaches to measuring money-risk tradeoffs, suggesting that it is important to examine the VSL figures produced by CV surveys.

Contingent valuation is a valuation technique that directly asks individuals to report information on their willingness to pay for an improvement in environmental quality, health or safety, or in the provision of a public good. This technique can and has been applied to both public and private goods. A change in the risk of death experienced by an individual, for example, is a public good if the risk reduction is delivered by a public

¹ Recently, the Agency has employed alternate estimates in several of its analyses: \$3.7 million based solely on the five stated preference estimates as well as a range of \$1-\$10 million based on meta-analytic results focused on hedonic wage studies.

program, such as an environmental or transportation safety program, but a private good if the risk reduction is delivered by an action or product (e.g., carbon monoxide detector) privately purchased and used by an individual.

In conjoint choice surveys, respondents are asked to state which they prefer between two commodities (or policy packages) described by a set of attributes. One of the attributes is usually the price of the good, or the cost of providing a government program. Because they are based on what individuals say they would do under specified, but hypothetical, circumstances, both contingent valuation and conjoint choice are examples of stated-preference methods for obtaining WTP for a commodity.

Contingent valuation has several advantages over other methods for measuring the value that people place over reductions in mortality risks. For example, in CV surveys respondents are generally told explicitly what the baseline risks and the risk reductions are. This is in sharp contrast with most compensating wage and other consumer studies, where it is assumed that individuals' perceived risks are equal to their objective risks. Moreover, the survey sample can be created to include persons of all ages, environmental exposures, and health status, whereas in labor market studies the population being studied is typically working males in their prime.

In contingent valuation surveys, changes in small probabilities have proven to be a very difficult commodity to value. Probabilities and risks must be explained to the respondents in the first place. Respondents may find it difficult to grasp that many risks can be avoided or reduced, but at a cost. Moreover, the risk changes to be valued are usually very small, and may be dismissed as meaningless by the respondents. It is, therefore, not surprising that many some CV surveys about reductions in mortality risks result in numerous zero WTP responses, and that the WTP amount announced by respondents sometimes fail to increase with the size of the risk reduction as predicted by economic theory (Hammit and Graham, 1999).

Statistical modeling of the WTP responses is further complicated by the fact that the underlying distribution of WTP has long and hard-to-nail-down tails, and that respondents with positive WTP must be distinguished from those respondents who hold no value at all for the risk reduction. This raises concerns about the robustness of these studies' estimates of mean and median WTP, and of the estimated relationships between WTP and individual characteristics such as income, age, education, and health status of the respondent. These relationships are used to test the internal validity of the WTP responses, and can potentially be used for benefit transfer purposes.

The purpose of this research is three-fold. The original goal of the research was to obtain the original survey data on which the five stated-preference estimates of VSL are based and re-analyze them to check the data quality and examine the robustness of the econometric estimates of VSL with respect to a variety of criteria (described below). The purpose of these analyses was to find out if alternative analyses and statistical models of the WTP data would have resulted in largely different estimates of WTP/VSL.

Second, we searched the recent literature on mortality risk valuation using stated-preference studies, examining carefully the survey materials and questionnaires, the risk reduction scenarios presented to the respondents, the wording and the nature of the payment questions, and the sample of respondents, seeking to draw lessons that could be used in interpreting results and estimates of VSL and in guiding future stated-preference studies about value of mortality risk reductions. Summaries of these studies are offered in Appendix A to this report. The questionnaires and our comments on their structure and quality are offered in Appendices B and C, respectively.

Third, for some of these papers or articles—those where the program delivering the risk reduction, the population surveyed, and the quality of the study itself suggest that results would be interesting and could be applicable to environmental policy—we obtained the original datasets from the authors and econometrically re-analyzed the WTP responses to assess the robustness of the estimates of WTP/VSL. Results are reported throughout this report.

It should be emphasized that the analyses conducted here are not meta-analyses of the VSL figures produced by stated preference studies. The purpose of this research is to examine the studies one by one, and not to uncover the across-study relationship between WTP and characteristics of the study design, the populations being surveyed, and the risk reductions being valued.

Briefly, we find that:

- Estimating mean WTP using the data from one-shot dichotomous choice questions can be problematic. Depending on the distribution assumed for WTP, mean WTP was either negative, or positive but implausibly large.
- When the analysis was conditional on covariates, we found that the relationship between WTP and one important covariate—the age of the respondent—was not robust to the procedure used for computing mean WTP.
- We recommend using dichotomous-choice CV questions with follow-up, even though the latter are not incentive compatible, to refine information about WTP and nail down the tails of the distribution of WTP.
- Median WTP is a robust and conservative welfare estimate.
- Debriefing questions should be included to uncover respondent failure to comprehend various aspects of the risk reduction scenario, yea-saying, nay-saying and completely random responses.
- In one of the studies we examined, we found that those respondents who reported a relatively high WTP for their income were probably persons who misunderstood the timing of the payments. Very high WTP relative to a person's income could also be due to income mismeasurement or failure to give the budget constraint proper consideration.

- When respondents are asked to estimate their own subjective risks and/or risk reductions, it is important to check whether WTP and subjective risks are endogenous. In one of the two examples presented in this report, we found that accounting for endogeneity of risks and WTP improved the sensitivity of WTP to the size of the risk reduction, which is an important internal validity criterion.
- We recommend that researchers express risk reductions in both absolute *and* relative terms. For example, they may say that the risk reduction is “5 in 10000. This represents a 30% reduction in your risk of dying.”
- We endorse the practice of showing the respondents one’s risk of death for a specific cause (e.g., traffic accidents) in the context of the risk of dying for all causes, and for other specific causes.
- Comparison of the visual aids used in various studies suggests that it is best to keep the visual depiction of risk as simple as possible.

The remainder of this report is organized as follows. Chapter 2 describes possible criteria to assess the econometric robustness of the estimates of WTP and VSL. Chapter 3 describes the studies that were identified for this work and the availability of data and questionnaires. Chapter 4 describes the studies for which we were able to obtain the original datasets.

The second part of the report is more empirical. Chapter 5 examines the importance of the assumptions about the distribution of WTP and of the formulae used to compute mean WTP in the context of (single-bounded) dichotomous-choice data. It also compares alternate welfare statistics, such as mean and median WTP. These issues are also examined in the context of analyses conditional on covariates, such as age.

Chapter 6 discusses outliers, and Chapter 7 possible sources of “contamination” of the responses, such as yea-saying, nay-saying, and completely random responses, presents mixture models. Attempts to estimate mixture models using maximum likelihood methods are presented for situations when the researcher suspects that such response patterns may exist, but does not have information from other survey responses that can be used to identify which respondents engage in such response behaviors. Chapter 8 focuses on alternative interpretations of the WTP responses, including zero responses and continuous versus interval data.

Chapter 9 focuses on the possible endogeneity of (subjective) risk and WTP, and explores how treating these variables as endogenous can affect scope tests and the issue of whether absolute or relative risk reductions drive WTP. Chapter 11 discusses sample selection issues, and chapter 12 discusses the main lessons learned from examining the questionnaires that were made available to us. Conclusions and recommendations are presented in Chapter 13.

Appendix A contains summaries of selected papers. Appendix B contains the questionnaire used in selected papers. Appendix C provides summaries and comments on the questionnaires. Appendix D contains research reports by the authors of the three of the four original studies.

2. POSSIBLE ROBUSTNESS CRITERIA

A. Data Quality Checks

The results from stated preference surveys are only as good as the data from which they are generated. There are several basic checks that help ensure data quality, including, for example, regressions that test internal validity of the WTP responses. We examine responses from several contingent valuation surveys eliciting WTP for mortality risk reduction to see if they satisfy basic requirements suggested by economic theory.

When the CV survey is conducted using the dichotomous-choice format,² for example, the percentage of “yes” responses to the payment question should decline with the bid amount. Figure 2.1 reports the percentage of “yes” responses to the payment question observed in a survey of US residents, where two independent subsamples of respondents were asked to report information about their WTP for risk reductions of different size. The figure shows that the percentage of “yes” responses declines regularly with the bid amount, ranging from 73% at the lowest bid amount (\$70) to 35% at the highest bid amount (\$725) for a risk reduction of 5 in 1000.

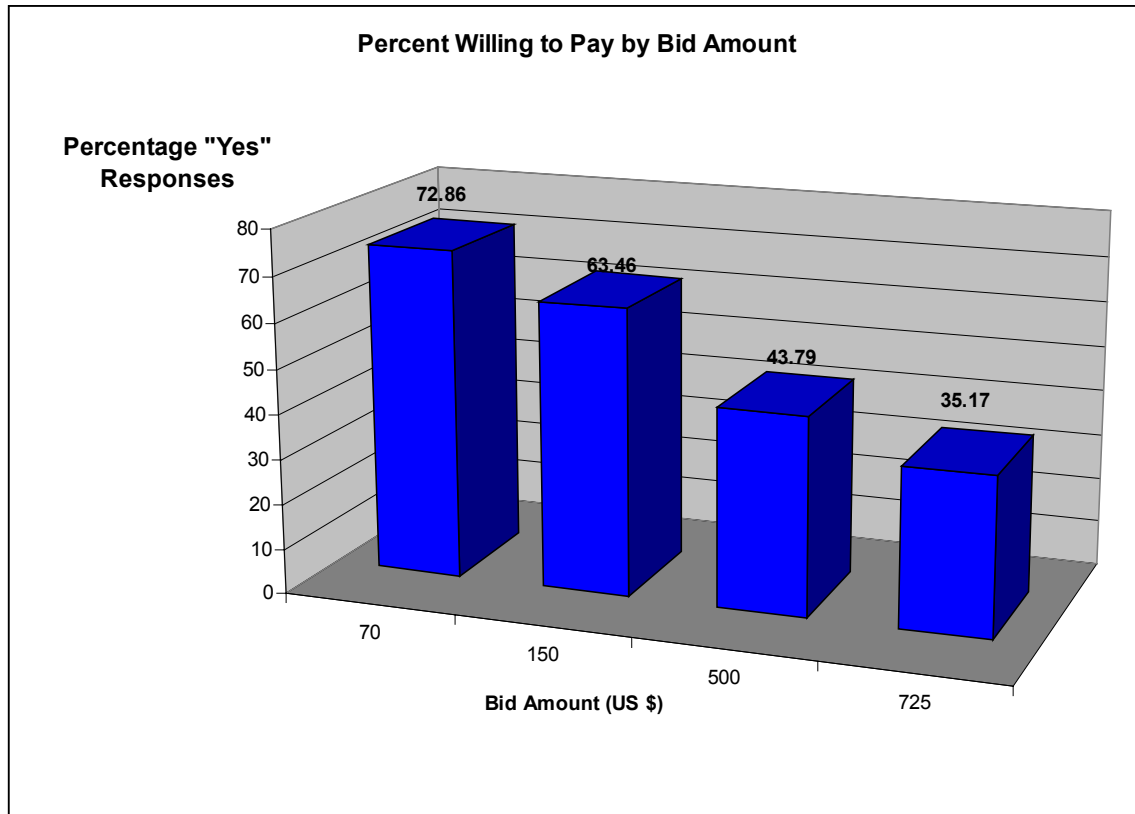
It is also important to check that the bid amounts assigned to the respondents in the survey cover a reasonable portion of the range of possible WTP values. For example, Alberini (1995a, 1995b) shows that when the distribution of WTP is assumed to be symmetric and the statistic of interest is mean/median WTP, placing the bids on one side of the median and/or too far away from the center of the distribution may result in a significant loss of efficiency of the estimates of mean/median WTP. Cooper (1993) emphasizes the importance of covering the entire range of possible WTP values.³

In much recent empirical work, WTP is assumed to follow an asymmetric distribution, such as the log normal or the Weibull. Failure to present respondents with bid amounts nicely spread over the possible range of WTP values, however, can seriously impair the researcher’s ability to obtain stable estimates of the parameters of the distribution.

² In a dichotomous-choice contingent valuation survey, respondents are asked to state whether or not they would purchase the good to be valued, or vote in favor or against a proposed government program, if the cost to their household was \$X. If the respondent is in favor of the program, or says he would buy the good, then his WTP exceeds \$X. If the respondent declines to buy the good, or votes against the program, then WTP must be less than the dollar amount X. The dollar amount, \$X, is generally termed the bid value, and is varied across respondents. Binary response econometric models are then fit to the responses to this payment question, and estimates of mean or median WTP are usually obtained exploiting the properties of the distribution WTP is assumed to follow (see, for example, Cameron and James, 1987).

³ Care should be taken, however, to avoid bid values that are implausibly small or large. The responses to the WTP questions for such amounts might reflect the loss of credibility of the scenario, rather than the true respondents’ preferences.

Figure 2.1 Percent of “yes” responses by bid value: US Study (Alberini et al, forthcoming).



In much recent empirical work, WTP is assumed to follow an asymmetric distribution, such as the log normal or the Weibull. Failure to present respondents with bid amounts nicely spread over the possible range of WTP values, however, can seriously impair the researcher's ability to obtain stable estimates of the parameters of the distribution.

B. Choice of distribution for WTP.

In their report of contingent valuation surveys eliciting non-use values for Prince William Sound in Alaska, Carson et al. (1995) show that the estimates of both mean and median WTP from dichotomous choice CV survey data can be very sensitive to the distributional assumption about WTP. This suggests that alternative distributional assumptions should be explored for the data from existing CV surveys. In particular, we wish to see what happens when we move away from logit or probit models of the responses to

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dichotomous choice payment questions used by many researchers, as these models imply that WTP is allowed to be negative.

We also wish to investigate the effect of using alternate procedures for computing mean WTP, holding the distribution of latent WTP the same. We extend this research question to the situation when the researcher is interested in estimating mean (median) WTP conditional on certain covariates of interest.

To elaborate on this latter point, willingness to pay for a mortality risk reduction is usually regressed on individual characteristics, including income, education, age and gender to test internal validity of the WTP responses. In addition to checking whether the results of the study are credible, these regressions also seek to answer questions related to the use of the VSL figures in policy analyses.

For example, there has been much recent interest in whether WTP for a risk reduction, and hence the VSL, is lower for elderly persons, reflecting their fewer remaining life years. Because economic theory does not offer unambiguous predictions about the relationship between VSL and age, the answer to this question is an empirical issue, and it is important to see if conclusions about the shape of the relationship between age and WTP depend on the procedure used for computing mean/median WTP.

C. Outliers

Collett (1991) defines as outliers “observations that are surprisingly far away from the remaining observations in the sample,” and points out that such values may occur as a result of measurement errors, execution errors (i.e., use of faulty experimental procedure), or be legitimate, if extreme, manifestations of natural variability.

Outliers with Respect to the Dependent Variable. Lanoie et al. (1995) explicitly consider respondents whose WTP amounts are disproportionately large relative to the rest of the sample. They identify three influential observations in their sample of workers of the Montreal area. When these observations are removed from the sample, the VSL estimated from the CV component of their study drops from \$22-27 million to \$15 million (1995 Can. Dollars).

Textbook presentations of the outlier problem sometimes recommend plotting the dependent variable of the regression against a regressor of interest to identify outliers through visual inspection, but it is clear that the responses to dichotomous-choice WTP questions do not easily lend themselves to such a treatment. In dichotomous-choice CV studies, WTP is not directly observed, suggesting that the formal definition of an outlier might be modified to denote an observation such that a “yes” response to the payment question predicted by the model was observed when the predicted probability of “yes” is very low, or a “no” response was observed when the probability of a “no” is very low (Copas, 1988).

Outliers in the Independent Variables. We also wish to examine the robustness of the estimates of WTP and VSL with respect to the presence of individuals who report (i) high values for certain independent variables, (ii) or high WTP amounts relative to the level of certain independent variables.

An example of (i) may occur when individuals are asked to estimate their own subjective risk and risk reductions. It is important to check whether WTP is sensitive to respondents with large self-assessed baseline risks or risk reductions, as these may signal failure to comprehend probabilities.

An example of (ii) is given by respondents whose announced WTP amounts are large relative to their income. Our interest in this question is motivated by the fact that in many CV surveys about environmental quality, researchers expect WTP to be a relatively small fraction of the respondent's income. This expectation has led them, in some cases, to exclude from the usable sample those respondents whose WTP is greater than, say, 5% of income.

When dealing with reductions in mortality risks there is no particular reason to believe that WTP should be a small fraction of income, but researchers sometimes do limit their regression analyses to those persons whose WTP for a mortality risk reduction is a relatively small proportion of household income. For example, in Persson et al. (2001) attention is restricted to those respondents whose WTP for a risk reduction in the coming year is less than 5% of annual household income.

Large WTP amounts relative to income may affect the income elasticity of WTP, which is important for benefit transfer purposes and when one wishes to predict WTP for the population. Moreover, large WTP amounts relative to one's income may signal a problematic WTP response. For example, the respondent may have failed to consider his or her income constraint. To identify outliers and assess their impact on the estimates of mean and median WTP, one might, therefore, consider excluding from the sample respondents whose implied WTP values exceed specified fractions of their income (e.g., 5%, 10% or 25% percent) and examining how the estimates of mean and median WTP, and income elasticity of WTP, change.

Outliers, continues Collett (1991), sometimes arise in the presence of *mixtures* of populations. We discuss mixtures of populations in the next section.

D. Discrete Mixtures.

Analyses of dichotomous-choice CV data rely on the assumption that respondents answer "yes" to a dichotomous choice payment question if their WTP amount is greater than the bid, and "no" when their WTP amount is less than the bid. It seems possible, however, that in some cases the sample might be "contaminated" with responses that do not abide by the economic paradigm.

Examples of such contaminating responses include “yea-saying,” “nay-saying,” and completely random responses. Yea-saying implies that the respondent answers “yes” with probability 1, regardless of the bid amount. By contrast, nay-saying implies that the respondent answers “no” with probability 1, regardless of the bid amount. When the responses are completely random, the respondent answers “yes” with probability 0.5, and “no” with probability 0.5, regardless of the bid value. This behavior is equivalent to letting the response to the payment question depend on the outcome of a coin flip.

Yea-saying behavior is possible, for example, when the respondent wishes to please the interviewer, or hopes that by answering affirmatively to the payment question the survey will be terminated soon. Nay-saying behavior, on the other hand, might be observed when the scenario is couched in terms of a public program, and the respondent dislikes certain aspects of government programs, even though, privately, he might attach a positive value to the good or environmental quality improvement provided by the program. It is also possible that respondents exhibit nay-saying behaviors when they are opposed to new taxes, and/or when they fear they are committing to something that they do not fully understand.

Finally, completely random responses might be due to complete confusion about the scenario, failure to understand the commodity being valued, no interest in the survey, and/or poorly written questions or survey materials. Completely random responses might also result from a data entry error, in which case, however, the problem arises for reasons other than the respondent’s behavior.

Because CV surveys eliciting WTP for mortality risk reduction must present respondents with probabilities, which are difficult for many people to process, and with scenarios that are sometimes difficult to grasp, there would seem to be room for these undesirable response effects in these studies. While it is possible, in some cases, to identify yea-sayers, nay-sayers and completely random responses by making judicious use of debriefing questions and interviewer observations, in other studies that use dichotomous choice payment questions it is not easy or possible to say whether the response to the payment question is legitimate or is due to one of these contaminating behaviors.

From the statistical point of view, when there is no data “separation” the presence of contaminating responses can be addressed by specifying a (discrete) mixture of distributions.⁵ In this report, for the sake of simplicity it is assumed that the observed sample responses come from a mixture with two components. Let the first component of the mixture be a well-behaved distribution of WTP with cdf $F(\bullet)$, while the second component of the mixture is yea-saying behavior. Let α be the probability of yea-saying behavior, while $(1-\alpha)$ is the probability of announced responses that are consistent with true WTP amounts. When a “yes” response is observed, then the contribution to the likelihood is

⁵ Known data separation is said to occur when the researcher knows exactly which of the two population the respondent belongs to.

$$(2.1) \quad \Pr(yes_i) = (1 - \alpha) \cdot \Pr(WTP_i > B_i) + \alpha \cdot 1 = (1 - \alpha) \cdot (1 - F(B_i; \theta)) + \alpha$$

where B is the bid amount, while the contribution to the likelihood by an observed “no” response is:

$$(2.2) \quad \Pr(no_i) = (1 - \alpha) \cdot \Pr(WTP_i \leq B_i) = (1 - \alpha) \cdot F(B_i; \theta) .$$

Equations (2.1) and (2.2) are, therefore, different from the typical contributions to the likelihood in statistical models of dichotomous choice responses, the difference arising from having to account for the fact that an observed “yes” has a probability $(1-\alpha)$ of being a genuine “yes” and α of being the result of yea-saying behavior.

When yea-saying exists and is not adequately accounted for, the estimated survival curve of WTP (i.e., 1 minus the cdf of WTP, which traces out the percentage of respondents willing to pay any given bid amount) lies above the true survival curve (see Figure 2.2). This will lead to overestimating both mean and median WTP.

Similarly, if the second of the two discrete components of the mixture was “nay-saying,” the appropriate contributions to the likelihood would be:

$$(2.3) \quad \Pr(yes_i) = (1 - \alpha) \cdot \Pr(WTP_i > B_i) = (1 - \alpha) \cdot (1 - F(B_i; \theta)),$$

and

$$(2.4) \quad \Pr(no_i) = (1 - \alpha) \cdot \Pr(WTP_i \leq B_i) + \alpha \cdot 1 = (1 - \alpha) \cdot F(B_i; \theta) + \alpha .$$

The estimated survival function of WTP will, therefore, lie below the true curve, which will result in underestimating mean and median WTP.

Finally, in the presence of completely random responses, the contributions to the likelihood are:

$$(2.5) \quad \Pr(yes_i) = (1 - \alpha) \cdot \Pr(WTP_i > B_i) + \alpha \cdot 0.5 = (1 - \alpha) \cdot (1 - F(B_i; \theta)) + 0.5\alpha$$

$$(2.6) \quad \Pr(no_i) = (1 - \alpha) \cdot \Pr(WTP_i \leq B_i) + \alpha \cdot 0.5 = (1 - \alpha) \cdot F(B_i; \theta) + 0.5\alpha .$$

The estimated survival curve will be below the true curve for bid amounts lower than the median, will cross the true curve at the median (since the probability of a “yes” is 0.5 for both legitimate responses and random responses) and will be above it for bid amounts greater than median WTP (see Figure 2.3).

The mixing probability α must be estimated by the method of maximum likelihood. It is also possible to make α a function of covariates, such as gender, age, education and attitudinal variables. As α is a probability, it is useful to specify a logit or probit link for α : $\alpha_i = \Phi(\mathbf{x}_i\gamma)$.

E. Alternative interpretations of the responses to the WTP questions

In the Gerking et al. study, respondents were asked to circle the amount on a payment card that best matched their willingness to pay. The WTP responses were treated as if they were on a continuous scale, although the correct interpretation is that an individual's WTP falls between the amount he or she picked on the payment card and the next highest amount (Cameron and Huppert, 1988). Re-specifying and re-estimating the likelihood function accordingly could result in different estimates of mean WTP, and in different regression coefficients. Presumably, the differences should depend on how broad the intervals around true WTP are, which in turn depends on how far apart the dollar amounts on the payment card are spaced, and on the underlying distribution of WTP (Cameron, 1987).

Another response interpretation issue examined in this report is the fact that, especially when the mortality risk reductions being valued are very small, many people state that they are not willing to pay anything at all to obtain the risk reduction. To our knowledge, the literature has handled this problem in three possible ways. The first is a tobit model, which has been used in some studies employing open-ended questions to elicit WTP (Gerking et al., 1988).

Second, the tobit model has also been adapted to the dichotomous choice context, in which case it has been sometimes referred to as the "spike" model (Kriström, 1997; Krupnick et al., 2002). Finally, in studies employing dichotomous choice questions with follow-ups, researchers have ignored respondents' final announcements that they were not willing to pay anything at all, and have simply assumed that these persons' WTP amounts lie between 0 and the lowest bid amount stated to the respondent in the follow-up payment question (Alberini et al., forthcoming). It is important to find out how these alternative approaches affect the final estimates of mean and median WTP.

F. Endogenous Regressors

Contingent valuation studies eliciting WTP for mortality risk reductions have sometimes asked respondents to evaluate their own baseline mortality risks (Gerking et al., 1988; Persson et al., 2001) and/or the risk reductions attainable if certain measures are taken or policies are passed (Johannesson et al., 1991).⁶ WTP is then regressed on baseline risk and/or the risk reduction.

⁶ In the Gerking et al. study, for example, respondents were asked to place their own occupation on a risk ladder, and to subsequently report their WTP (WTA) for reducing (increasing) risk by one notch. In the Persson et al. survey, respondents were first asked to subjectively estimate their own risk of dying in a road-traffic accident, after being told what the risk was for a 50-year-old person. They were then asked to report their WTP for a reduction of 10, 30, 50 or 99 percent in the risk of dying in a road-traffic accident. Finally, Johannesson et al. (1991) contacted patients at a health care center in Sweden,

In studies conducted in this fashion, one expects WTP to increase with the size of the absolute risk reduction, and, ideally, to be strictly proportional to the size of the risk change (Hammitt and Graham, 1999). Before one sets out to test hypotheses about the coefficient of the risk reduction, however, it is important to establish if WTP and self-assessed risks (or risk reductions) are econometrically endogenous with one another. This happens, for example, when these variables share common unobservable individual characteristics.

Coefficient estimates based on OLS or maximum likelihood estimation that treat risk as exogenous will be biased, resulting in incorrect inference about the relationship between WTP and risk, and in biased estimates of the VSL. To address this problem, it is necessary to specify an additional equation relating respondent-assessed baseline risks to respondent characteristics and other exogenous factors that serve as instruments, and to estimate two systems of simultaneous equations, one for self-assessed risks (or risk reductions) and one for WTP.

G. Sample Selection Bias.

If the propensity to participate in a mortality risk survey depends on unobservable individual characteristics that also influence WTP for risk reductions, then the estimates of WTP may be affected by sample selection bias. To correct for it, it is necessary to specify and estimate two econometric equations. The first is a probit equation that predicts the probability of participating in the survey as a function of individual characteristics. Let P^* denote propensity to participate, a continuous but latent variable:

$$(2.7) \quad P_i^* = \mathbf{z}_i \gamma + \eta_i$$

with \mathbf{z} a vector of individual characteristics, γ a vector of coefficients, and η a normally distributed error term with mean zero and variance equal to one. Let P be a binary indicator that takes on a value of 1, denoting participation in the survey, if P^* is greater than zero, and zero otherwise.

The second equation explains WTP as a function of a vector of individual characteristics \mathbf{x} and experimental treatments exogenously assigned to the respondent (e.g., the size of the risk reduction to be valued):

$$(2.8) \quad WTP_i^* = \mathbf{x}_i \beta + \varepsilon_i,$$

where η and ε are correlated, their covariance being equal to σ . Because WTP is observed only for those persons who participated in the survey, one estimates

asking them to assess their subjective risks of death due to hypertension and their subjective risk reduction associated with a medical intervention.

$$(2.9) \quad WTP | P^* > 0 = \mathbf{x}_i \beta + \sigma \frac{\phi(\mathbf{z}_i \gamma)}{\Phi(\mathbf{z}_i \gamma)} + \text{error}.$$

In practice, this system of equations can be estimated in two stages. The first stage is a probit predicting the probability of participating in the survey. The estimated coefficients are used to build the Mills' ratio term $\phi(\mathbf{z}_i \hat{\gamma}) / \Phi(\mathbf{z}_i \hat{\gamma})$ to be included in the WTP equation. This is a limited-information maximum likelihood estimation (LIML) approach.

Once the two-stage estimation procedure is completed, mean WTP is estimated (assuming normally distributed WTP) as $\bar{x} \hat{\beta}$. Notice that the estimate of β is biased unless one explicitly includes the correction term $\phi(\mathbf{z}_i \hat{\gamma}) / \Phi(\mathbf{z}_i \hat{\gamma})$ in the WTP equation. It should also be noted that correct implementation of the two-stage estimation procedure requires that the standard errors in the second stage be corrected using the formulae provided in Murphy and Topel (1985). (Alternatively, the system of equations can be estimated by full-information maximum likelihood.)

It is clear that to estimate the probit model of participation information about the survey participants is necessary, as well as information about those persons who were sent questionnaires or otherwise solicited to participate in the survey, but declined to. With mail surveys, Cameron et al. (1999) suggest saving the addresses and zipcodes of all individuals who were sent questionnaires and imputing to those persons who do not return the completed questionnaire the characteristics (such as median income, percentage of college-educated adults, percent of home ownership, etc.) from the Census of the residents of his or her zipcode. This procedure assumes that an individual is much like his or her [avoid he or she; his or her...pick one and go with it] neighbors. With phone surveys, it might be possible to ask some questions of the person who answers the telephone, and to obtain some information about him or her, even if he or she elects not to continue the survey.

Figure 2.2. Effect of yea-saying.

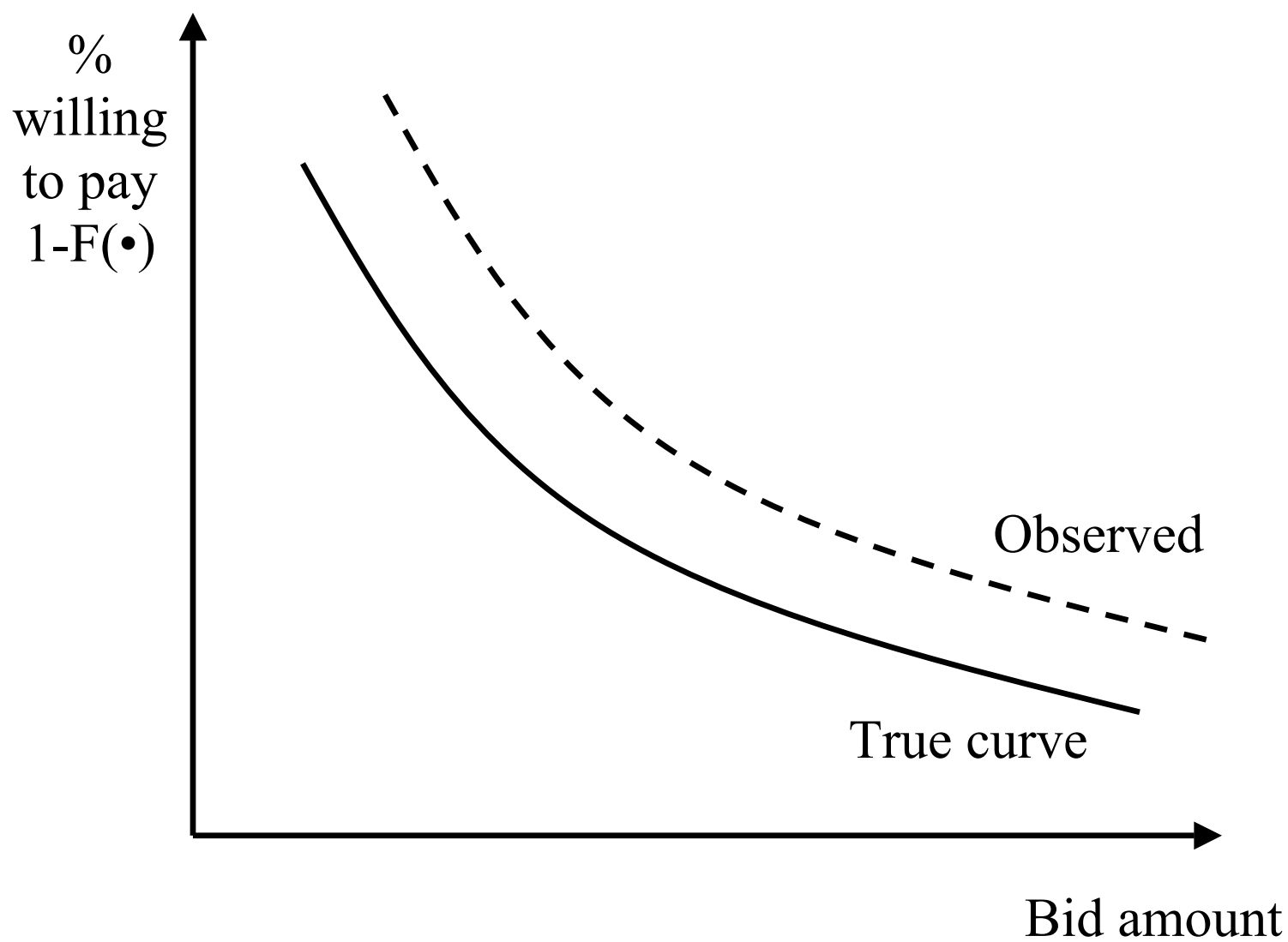
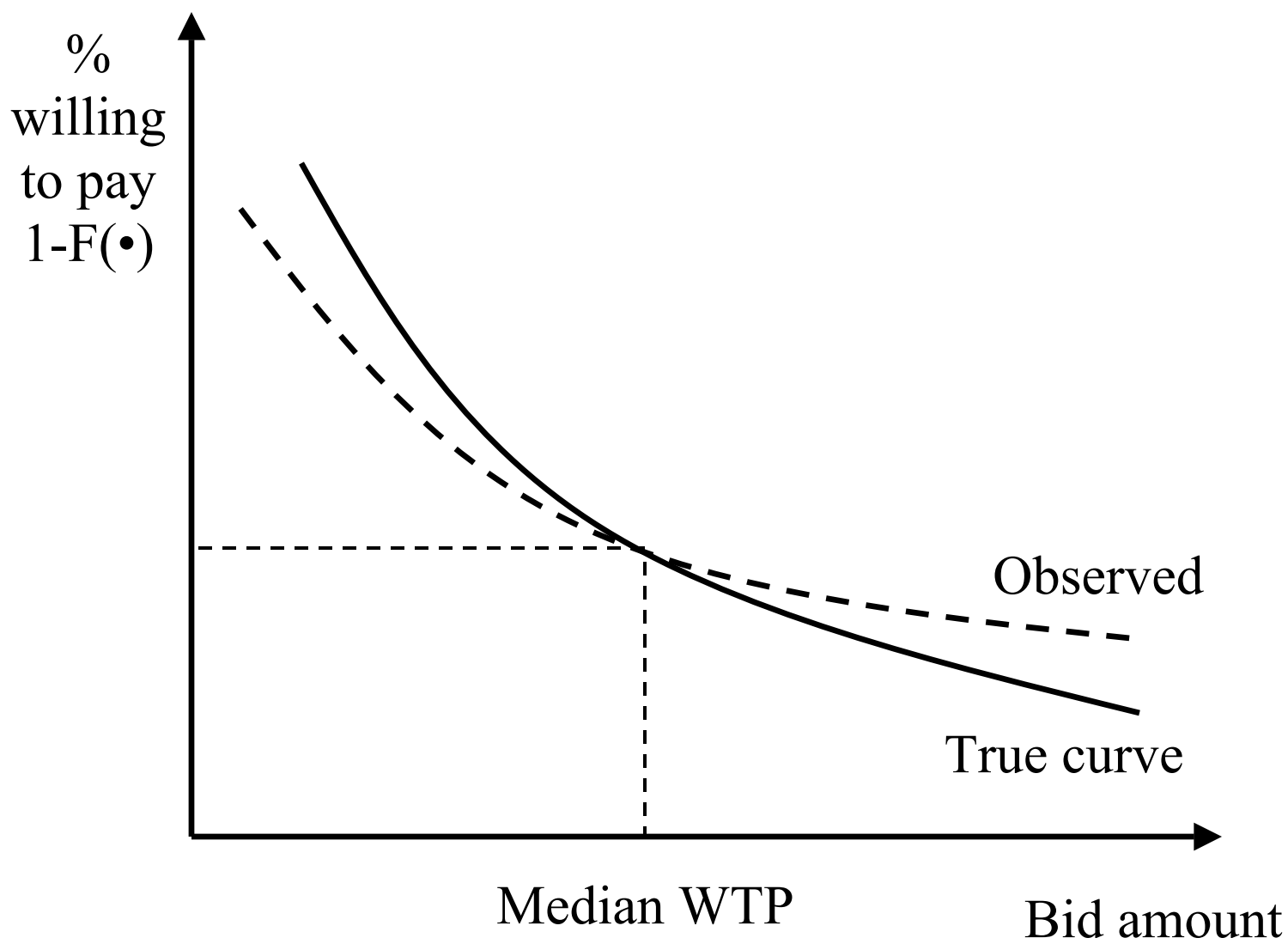


Figure 2.3. Effect of Completely Random Responses.



3. DATASETS REQUESTED AND REQUEST STATUS

One of the goals of this research project was to examine the robustness of the VSL estimates from CV studies used by the US EPA in its policy analyses. The five estimates—corresponding to four studies—are listed in table 3.1, which also presents a succinct description of these studies and their VSL figures.

Table 3.1. Original Studies: Description, VSL figures, and Data Availability

Study	Description
Gerking, Shelby et al. (1988), “The Marginal Value of Job Safety: A Contingent Valuation Study,” <i>Journal of Risk and Uncertainty</i> , 1(2), 185-200	Mail survey (national sample) asking respondents to report wages, occupation, other respondent characteristics. Respondents are asked to identify their job on a risk ladder, then to report WTP (WTA) for a reduction (increase) by one step on the ladder. VSL = \$2.66 million (based on WTP) VSL used by EPA: \$4.1 million (1997 \$)* Data and questionnaire available.
Gegax, Douglas, Shelby Gerking and William Schulze (1985), <i>Valuing Safety: Two Approaches, in Experimental Methods for Assessing Environmental Benefits, Volume IV. Report prepared for the U.S. EPA, Office of Policy Analysis under Assistance Agreement #CR811077-01.</i>	Same survey as above. The questionnaire includes questions about income, type of occupation and industry, perceived risks of various injuries and deaths in the workplace, experience, etc. The responses to these questions are used to estimate a compensating wage equation. VSL = \$2.136 million (based on WTP) VSL used by EPA: \$4.0 million (1997 \$)* Data and questionnaire available.
Miller, T. and J. Guria (1991), <i>The Value of A Statistical Life in New Zealand</i> , Wellington, New Zealand: Land Transport Division, New Zealand Ministry of Transport.	In-person survey (national sample) asking respondents a mix of contingent valuation, contingent behavior, and other choice questions (which city they would live in). VSL = NZ \$1.893 (average of all questions) VSL used by EPA: \$1.5 million (1997 \$)* Data and questionnaire not available.
Viscusi, W. Kip, Wesley A. Magat and Joel Huber (1991a), <i>Issues in Valuing Health Risks: Applications of Conjoint Valuation</i>	Uses risk-risk and risk-money tradeoffs to infer the value attached to three diseases potentially associated with environmental

<p><i>and Conjoint Measurement to Nerve Disease and Lymphoma</i>, Draft report to EPA, Office of Policy, Planning and Evaluation, under Assistance Agreement CR# 815455-01-1 and 814388-02.</p>	<p>exposures:</p> <ul style="list-style-type: none"> - peripheral neuropathy [a nerve Disease]; → VSL = \$1.6 million. - curable lymphoma (chance of dying 10%) → VSL = \$2.5 million - terminal lymphoma (chance of dying 100%) → VSL = \$4.0 million <p>VSL used by EPA: \$3.3 million (1997 \$)*</p> <p>Data no longer exist; questionnaire not available.</p>
<p>Jones-Lee, Michael W. (1989), <i>The Economics of Safety and Physical Risk</i>, Oxford, Great Britain: Basil Blackwell.</p>	<p>National sample, mix of choice and CV questions.</p> <p>VSL used by EPA: \$4.6 million (1997 \$)*</p> <p>Questionnaire not available. Declined to obtain the data.</p>

* As reported in US Environmental Protection Agency (2000), Guidelines for Preparing Economic Analyses, Office of the Administrator, EPA Report 240-R-00-003, Washington, DC, September.

We approached the authors of three of the four original stated-preference studies to supply the data collected through their surveys. Only Dr. Gerking was able to provide the dataset used for his report to the US EPA (Gegax et al. 1985) and for his 1988 article; data for a number of the remaining studies were not available: Drs. Viscusi and Huber no longer have the data supporting their 1991 study. Ted Miller also said that he did not have the data from his 1991 study co-authored with Guria. Regarding the last stated-preference study, the one by Dr. Jones-Lee, we declined to obtain and work with these data, due to data quality concerns.

As the data for the older studies were lacking, we selected a number of recent articles estimating the VSL using contingent valuation surveys, and requested the authors to share their data, questionnaires, reports and programs, and any other useful supporting materials for this exercise.

The studies that we identified as potentially interesting were as follows:

- (i) Johannesson et al. (1991): This study focuses on persons with high blood pressure. These persons may be more susceptible to the effects of certain pollution exposures, such as particulate matter in the air and heavy metals;
- (ii) Lanoie et al. (1995): The authors' goals were similar to those of the Gerking et al. study, in that they wished to compare wage-risk tradeoffs in the workplace with stated WTP for a risk reduction. The risks presented to the respondents were of the correct magnitude;

- (iii) Johannesson et al. (1997): This study focuses on the relationship between age and VSL;
- (iv) Johannesson and Johansson (1996): This study focuses on lifetime extensions to be experienced in the future, rather than risk reductions;
- (v) Persson et al. (2001): This study was carefully conducted study in the context of road transportation safety, and
- (vi) Corso et al. (2001): This paper explores whether failure of WTP to increase and/or be proportional with the size of the risk reduction is due to poor understanding of probabilities on the part of the respondents, and if this can be addressed with appropriate visual aids.
- (vii) In addition, the data from surveys in Canada and the US based on similar survey instruments (Krupnick et al., 2002, and Alberini et al., forthcoming) are available to us. The latter two studies examine the relationship between VSL and age and health status, and elicit WTP for future risk reduction, seeking to estimate the implicit discount rate(s) of the respondents (Alberini et al., 2004).

Table 3.2 summarizes these more recent studies, along with the status of the data and questionnaires. In terms of the approach for eliciting WTP, and hence the econometric models, these studies include both one-shot dichotomous choice WTP questions (Johannesson et al., 1996, 1997), dichotomous choice questions with follow-ups (Krupnick et al., and Alberini et al.), and the open-ended format (Lanoie et al., Persson et al.). The mode of administration included mail surveys (Persson et al.), telephone surveys (Johannesson et al., 1996, 1997), combination telephone-mail-telephone (Corso et al.), in-person interviewing (Lanoie et al.) and self-administered computer questionnaires (Krupnick et al., Alberini et al.).

One caveat is in order. None of these studies explicitly refers to the environmental exposure context. However, Desaigues et al. (2003), in discussing an application of the Krupnick et al. questionnaire in France, argue that perhaps this is the only recent mortality risk CV study that can be applied in a straightforward fashion to the context of air pollution. We also wish to emphasize that in all of the studies listed in table 3.2, the risk reduction to be valued by the respondent is of a private nature, and is delivered by a hypothetical medical intervention or product, or (in the case of road transportation risks) by an unspecified safety device (Persson et al.) or by side-impact airbags (Corso et al.).

Table 3.2. Recent Mortality WTP Studies and Data Availability.

Authors and article	Availability of Data and Questionnaire
Johannesson, Magnus, Bengt Jonsson, and Lars Borquist (1991), "Willingness to Pay for Antihypertensive Therapy—Results for a Swedish Pilot Study," <i>Journal of Health Economics</i> , 10, 461-474.	Data no longer exist.
Lanoie, Paul, Carmen Pedro and Robert Latour (1995), "The Value of a Statistical Life: A Comparison of Two Approaches," <i>Journal of Risk and Uncertainty</i> , 10. 235-257.	Questionnaire available; data no longer exist.
Johannesson, Magnus and Per-Olov Johansson (1996), "To Be, or Not to Be, That is the Question: An Empirical Study of the WTP for an Increased Life Expectancy at an Advanced Age," <i>Journal of Risk and Uncertainty</i> , 13, 163-174.	Data are available. Data received: ADVAGEFILE.SAV (SPSS dataset), converted into ADVAGE.SD2 (SAS dataset). Basic analyses in ADVAGE DATAPREP.SAS. Questionnaire available (in Swedish and English translation).
Johannesson, Magnus, Per-Olov Johansson, and Karl-Gustav Lofgren (1997), "On the Value of Changes in Life Expectancy: Blips versus Parametric Changes," <i>Journal of Risk and Uncertainty</i> , 15, 221-239.	Data are available. Data received: VSLFILE.SAV (SPSS dataset), converted into VSLFILE.SD2 (SAS dataset). Basic analyses in VSLFILE DATAPREP.SAS. Questionnaire available (in Swedish and English Translation).
Persson, Ulf, Anna Norinder, Krister Hjalte and Katarina Gralen (2001), "The Value of a Statistical Life in Transport: Findings from a New Contingent Valuation Study in Sweden," <i>Journal of Risk and Uncertainty</i> , 23(2), 121-134.	Data are available. Data received: ENKELTOTALLA.SAV (SPSS dataset), converted to SAS (ENKELTOTALLA.SAS7BDAT). SAS program for data analysis is DATAPREP2.SAS. Questionnaire available (in Swedish and English translation).
Corso, Phaedra S., James K. Hammitt, and John D. Graham (2001), "Valuing Mortality-Risk Reduction: Using Visual Aids to Improve the Validity of Contingent Valuation," <i>Journal of Risk and Uncertainty</i> , 23(2), 165-184	Questionnaire available. First author declined to supply the data because she has not completed the analysis.
Krupnick, Alan, Anna Alberini, Maureen Cropper, Nathalie Simon, Bernie O'Brien, Ron Goeree, and Martin Heintzelman (2002), "Age, Health, and the Willingness to Pay for Mortality Risk Reductions: A Contingent Valuation Survey of Ontario	Data available. Self-administered computer questionnaire available upon request.

Residents,” <i>Journal of Risk and Uncertainty</i> , 24, 161-186.	
Alberini, Anna, Maureen L. Cropper, Alan Krupnick, and Nathalie Simon (forthcoming), “Does the Value of a Statistical Life Vary with Age and Health Status? Evidence from the U.S. and Canada,” <i>Journal of Environmental Economics and Management</i> .	Data available. Self-administered computer questionnaire available upon request.

4. DESCRIPTION OF THE STUDIES

In this section, we briefly describe the studies we use to examine the importance of various econometric modeling issues in deriving the VSL. A summary of these studies and their VSL figures is displayed in table 4.1.

Table 4.1. Mortality Risk Studies Re-analyzed in this Report.

Study	Description and VSL
<p>Gerking, Shelby et al. (1988), "The Marginal Value of Job Safety: A Contingent Valuation Study," <i>Journal of Risk and Uncertainty</i>, 1(2), 185-200</p> <p>Gegax, Douglas, Shelby Gerking and William Schulze (1985), Valuing Safety: Two Approaches, in <i>Experimental Methods for Assessing Environmental Benefits</i>, Volume IV. Report prepared for the U.S. EPA, Office of Policy Analysis under Assistance Agreement #CR811077-01.</p>	<p>Mail survey (national sample) asking respondents to report wages, occupation, other respondent characteristics. Respondents are asked to identify their job on a risk ladder, then to report WTP (WTA) for a reduction (increase) by one step on the ladder.</p> <p>VSL = \$2.66 million.</p>
<p>Johannesson, Magnus, and Per-Olov Johansson (1996), "To Be, or Not to Be, That is the Question: An Empirical Study of the WTP for an Increased Life Expectancy at an Advanced Age," <i>Journal of Risk and Uncertainty</i>, 13, 163-174.</p>	<p>Telephone survey of Swedes aged 18-69. Respondents are told what their chance of surviving to age 75 is, and then are asked DC questions about WTP for a medical intervention that increases their life expectancy at age 75 by one year.</p> <p>VSL = \$101,000.</p>
<p>Johannesson, Magnus, et al. (1997), "On the Value of Changes in Life Expectancy: Blips versus Parametric Changes," <i>Journal of Risk and Uncertainty</i>, 15, 221-239.</p>	<p>Telephone survey of Swedes aged 18-74. DC questions about WTP for 2 in 10,000 reduction in their risk of dying (from all causes).</p> <p>VSL \cong \$4.5 million.</p>
<p>Persson, Ulf, et al. (2001), "The Value of a Statistical Life in Transport: Findings from a New Contingent Valuation Study in Sweden," <i>Journal of Risk and Uncertainty</i>, 23(2), 121-134.</p>	<p>Mail survey in Sweden. Elicits WTP for X% reduction in the risk of dying in a road-traffic accident. Subjective baseline risks.</p> <p>VSL = \$2.84 million (based on WTP for 2 in 100,000 risk reduction).</p>
<p>Krupnick, Alan, et al. (2002), "Age, Health, and the Willingness to Pay for Mortality Risk Reductions: A Contingent Valuation Survey of Ontario Residents," <i>Journal of Risk and Uncertainty</i>, 24, 161-186.</p>	<p>Survey of persons aged 40-75 years in Hamilton, Ontario. Self-administered computer questionnaire, centralized facility.</p>

	VSL = Can \$1.2 to 2.8 million.
Alberini, Anna, et al. (forthcoming), “Does the Value of a Statistical Life Vary with Age and Health Status? Evidence from the U.S. and Canada,” <i>Journal of Environmental Economics and Management</i> .	US national survey conducted over Web-TV. VSL = \$700,000 to \$1.54 million (based on 5 in 1000 risk reduction)

A. Johannesson et al. 1996 study

The first of the two data sets provided by Magnus Johannesson was that used in his 1996 paper co-authored with Per-Olov Johannesson “To Be, or Not to Be, That Is the Question: An Empirical Study of the WTP for an Increased Life Expectancy at an Advanced Age.” [Full citations are provided several times in tables. Don’t think you need to include here.] In this study, a random sample of the population of 18-69 year-olds in Sweden was interviewed over the telephone in June 1995. Respondents were told that a person of their age and gender had a probability of X of surviving until age 75. Respondents were told that on average a 75-year old lives for an additional ten years, and were asked to consider a medical treatment that increases expected remaining life at age 75 by another year. Respondents were then asked whether they would choose to buy this treatment if it cost [FILL] SEK and has to be paid for this year.

The purpose of the study is, therefore, to elicit WTP for a future life extension, and the elicitation method is a single-bounded dichotomous choice payment question.⁷ There were a total of 6 bid values: 100, 500, 1000, 5000, 15000 and 50000 SEK, with one US dollar equivalent to 7.25 SEK at the time of the study.

A total of 2013 respondents agreed to participate in the survey. The probabilities of survival until age 75 varied with the respondent age and gender, but the length of the extension of the expected remaining life at age 75 was the same—one year—for all respondents.

Table 4.2 reports the number of respondents assigned to each bid value and the percentage of “yes” responses to each bid value. Clearly, median WTP is between 100 and 500 SEK. In practice, the bid design covers only the upper tail of the distribution of WTP, raising questions about the quality of the estimates of mean and median WTP, if the researchers wishes to fit a binary response model assuming that the distribution of WTP is skewed.

⁷ The original questionnaire also queried respondents about how confident they felt about their responses to the payment question. Specifically, as shown in Appendix B, people who answered “yes” to the dichotomous choice question were asked whether they felt “totally certain” or “fairly certain” that they would buy the treatment at the stated cost. The dataset supplied by Dr. Johannesson includes a variable, WTPCONS, an indicator that takes on a value of one if and only if the respondent was absolutely sure that he would pay, and zero otherwise.

Table 4.2. Bid Design and “Yes” Response Rates in Johannesson and Johansson (1996).

Bid value (1995 SEK)	Number of respondents	Percent willing to pay the bid
100	342	53.22
500	337	38.58
1000	325	31.38
5000	327	22.63
15000	352	13.64
50000	330	9.09

The dataset also contains the following variables:

- Respondent age,
- household size,
- education (1=less than high school, 2=high school, 3=university),
- personal monthly pre tax income, and
- sex.

Descriptive statistics for these variables are reported in Table 4.3.

Table 4.3. Descriptive Statistics of the Data. Johannesson and Johansson (1996).

Variable (variable description)	Number of valid observations	Mean	Std deviation	Min	Max
PRICE (bid)	2013	11894	17667	100	50000
WTP (response to the payment question)	2013	0.2811	0.4496	0	1
AGE	2013	42.11	14.05	18	69
HSIZE (size of the household)	2007	2.6253	1.2973	1	7
EDU (categorical variable for educational attainment)	2007	2.0842	0.7883	1	3
PINC (personal income) ⁸	1927	14397.51	9122.38	0	99000

⁸ Household income was supposed to be included in the dataset, but the authors of the article found something wrong with that variable in the file, as it had missing values for all households with more than one member (Magnus Johannesson, personal communication, April 2002).

In addition to producing estimates of WTP based on a binary logit model, Johannesson and Johansson separate the data by age group of the respondent, and fit separate logit models to each of the subsamples derived in this fashion. They then predict mean WTP for each age group, and trace out the profile of (mean) WTP over age, concluding that WTP for an extension in life expectancy past a certain age increases with age.

B. Johannesson et al. 1997 study

The second dataset supplied by Dr. Johannesson was used in the paper “On the Value of Changes in Life Expectancy: Blips versus Parametric Changes,” and was co-authored with Per-Olov Johansson and Karl-Gustaf Lofgren.

The authors report on a telephone survey of a representative sample of the population of Sweden of ages 18-74. The final sample is comprised of 2029 individuals, for a response rate of 83 percent. The survey was conducted from September to November 1996.

Respondents were told that X out of 10000 people of their gender and age would die during the next year.⁹ They were also asked to assume that a preventative and painless treatment were available that would reduce by 2 in 10000 the risk of dying in the next year, but have no effects thereafter.

The bid levels used in this study were 300, 500, 1000, 2000, 5000 and 10000 SEK. Table 4.4 shows the percentage of respondents assigned to each of the bid values and the percentage of “yes” responses at each bid level.

Table 4.4 Experimental Design and “Yes” Response Rates in the Johannesson, Johansson and Lofgren study, 1997.

Bid amount	Number of respondents	Percentage “yes” responses
300	405	51.36
500	410	44.63
1000	196	37.76
2000	406	36.70
5000	410	34.10
10000	201	28.83

⁹ The baseline risk of death over the next year was 10, 30, 70, and 200 for males in the age groups 18-39, 40-49, 50-59, and 60-69, respectively. For females, the baseline risk values were 5, 20, 40, and 100. All baseline risks are out of 10000.

The percentages of “yes” responses follow a pattern similar to that of Table 4.3, in that they (i) decline monotonically with the bid amount, (ii) imply only limited coverage of the range of WTP values, and (iii) imply that median WTP is between 300 and 500 SEK.

Johannesson et al. estimate mean WTP (and hence VSL) by age group. They obtain an inverted-U shape profile of the relationship between WTP and age.

Descriptive statistics of the other variables included in the dataset provided by Dr. Johannesson are shown in Table 4.5.

Table 4.5. Descriptive Statistics of the data. Johannesson et al. study, 1997.

Variable (variable description)	Number of valid observations	Mean	Std deviation	Min	Max
PRICE (bid)	2029	2658.95	2976.25	300	10000
WTP (response to the payment question)	2028	0.3999	0.4900	0	1
AGE	2027	45.08	15.21	18	75
HSIZE (size of the household)	2026	2.60	1.37	1	9
EDU (categorical variable for educational attainment)	2019	2.02	0.80	1	3
PINC (personal income, thou. SEK)	1929	14.24	8.08	0	99
QOL (Quality of life, 1=lowest quality of life, 10=highest quality of life)	1990	7.34	1.77	1	10
HINC (household income, thou. SEK)	1692	24.49	12.86	0	99
SEX (1=male)	2029	0.4785	0.4996	0	1

C. Gerking et al. study (1988)

The dataset submitted by Dr. Gerking matches almost perfectly the sample detailed in the Gerking et al. (1988) article.¹⁰ This survey was conducted by mail. Questionnaires were sent to 3000 households representative of the population of the US, and to 3000 households drawn from US counties with a high representation of risky industries.

Starting from a total of 969 returned questionnaire, Gerking et al.’s usable sample excludes the 11 persons who failed to report WTA or WTP amounts, restricting attention

¹⁰ These same data were used in Gegax et al. 1985.

to 459 observations for WTA, and 499 for WTP. Gerking et al. further exclude from the sample (i) the three respondents who are retired or unemployed, and (ii) the 58 respondents who did not indicate their initial risk level. The final sample is comprised of 904 observations, 428 for WTA (q6type=1) and 476 for WTP (q6type=2). Descriptive statistics for this cleaned sample are displayed in table 4.6.

Table 4.6. Descriptive statistics for the Gerking et al. data.

(a) Willingness to Accept Subsample

variable	N	Mean	Std. Dev.	Minimum	Maximum
WTA	428	1871.15	2215.36	0	6001.00
education	379	15.11	2.89	11	23
Age	427	41.80	11.87	19	71
income	378	28,369.96	21166.12	28	200,000
Black (dummy)	427	0.02	0.15	0	1
Hispanic	428	0.007	0.08	0	1
Male	427	0.85	0.35	0	1
Union member	424	0.27	0.44	0	1
Subjective risk	409	0.00065	0.00054	0.00025	0.00225
Objective risk	428	0.00007	0.00009	0	0.00064
Lives in central city (dummy)	426	0.14	0.35	0	1
Lives in suburban area (dummy)	428	0.54	0.50	0	1
Lives in rural area (dummy)	428	0.31	0.46	0	1

(b) Willingness to Pay Subsample

variable	N	Mean	Std. Dev.	Minimum	Maximum
WTA	476	678.60	1554.85	0	6001
education	404	14.94	2.65	11	23
Age	470	40.80	11.70	20	75
income	415	27,686.17	20,944.37	0	250,000
Black (dummy)	468	0.03	0.18	0	1
Hispanic	476	0.02	0.16	0	1
Male	470	0.82	0.38	0	1
Union member	467	0.29	0.45	0	1
Subjective risk	466	0.0008	0.00049	0.0005	0.0025
Objective risk	476	0.000076	0.00010	0	0.00064
Lives in central city (dummy)	470	0.17	0.37	0	1
Lives in suburban area (dummy)	476	0.55	0.50	0	1
Lives in rural area (dummy)	476	0.27	0.45	0	1

D. Krupnick et al studies

The Krupnick et al. studies (Krupnick et al., 2002; Alberini et al., forthcoming) were conducted in Hamilton, Ontario in Spring 1999, and in the US in August 2000. Respondents in the Canada study were recruited by random digit dialing and asked to go to a centralized location to take the survey, which was self-administered using the computer. Respondents for the US study, which was nationwide, were selected among members of a panel of households developed by Knowledge Networks, were solicited to participate in the survey via e-mail, and took the survey via Web-TV.

The purpose of these two studies was three-fold. First, the researchers wished to examine the relationship between age and WTP, which is important for environmental policy purposes, as many environmental programs save primarily the lives of older people. Second, they wished to examine the relationship between health status and WTP. This is also important for policy purposes, as some agencies have argued in favor of the use of Quality Adjusted Life-Years (QALY), a concept widely used in medical decisionmaking where values are adjusted for quality of life, which is presumably lower for chronically ill people. Third, they wished to examine the matter of latency.¹¹

¹¹ By latency, these authors refer to a risk reduction that takes place in the future, but for which investment must be made now.

In both studies, the survey begins by asking for the respondent's age and gender, inputs required for the purpose of showing the respondent age- and gender-specific baseline risks of dying. The questionnaire then asks whether the respondent suffers from heart disease, chronic respiratory illness, has high blood pressure, and has or has had cancer.¹² Respondents are also asked whether family members suffered from these illnesses.¹³

The survey continued with a simple probability tutorial and with a probability quiz and a probability choice question intended to test their comprehension of probabilities. This part of the survey introduced the risk communication device used throughout the survey, i.e., a grid with 1000 squares, where white squares represent survival and red squares represent death.

People were then shown the risk of dying for the average person of their age and gender over the next ten years. Risks were expressed as X per 1000. People were also shown the increase in the risk of dying for different age groups, and were subsequently informed that measures can be taken to reduce these risks. Subjects were given examples of actions that can be taken to reduce risks, along with qualitative information about the expensiveness of such actions.

In the contingent valuation scenario respondents were asked to consider a reduction in the risk of dying, shown graphically by changing the corresponding number of squares from red to blue, delivered by a hypothetical product. If the product had to be taken for 10 years, and paid for every year, to secure the risk reduction, the questionnaire continued, would the respondent be willing to pay \$Y per year for that product? Based on the response to this question, respondents were queried about a higher dollar amount (if yes) or a lower dollar amount (if no). Those respondents who answered "no" twice were asked whether they were willing to pay anything at all, and, if so, how much.

Respondents valued a total of three risk reductions. Two of them would begin immediately and take place over the next 10 years, while the last was to be experienced at age 70. (The latter risk reduction was valued only by respondents of age 60 and younger.) The graphical presentation emphasized the overlap between the timing of the payments and the timing of the risk reduction (for the immediate risk reductions), or the delay

¹² The questions about chronic illnesses questions were more detailed and precise in the US study. Respondents were asked if they had even been diagnosed by a health care professional as having coronary disease, high blood pressure, asthma, chronic bronchitis, emphysema, high blood pressure, other heart disease, and if they had ever had a myocardial infarction (a heart attack), a stroke, and ever been diagnosed with cancer.

¹³ The presence of these illnesses in the family may influence the respondents' acceptance of the risks stated to them in the survey, their subjective probabilities of surviving to age 70, and their subjective expected lifetime, thereby affecting their willingness to pay figure. Familiarity with these illnesses may also have an independent effect on WTP. In the US, people were also asked whether their natural parents were alive, and if so, how old they were (or at what ages they died).

between them (for the future risk reduction). Clearly, in this survey respondents value a private risk reduction.

As shown in Table 4.7, the survey was administered using a split sample approach with respondents randomly assigned to one of two waves and the order in which the risk reductions were shown to the respondents varying across waves. This allows an external scope test between WTP for the 5 in 1000 risk reduction (wave 1) and WTP for the 1 in 1000 risk reduction (wave 2), in addition to allowing one to perform internal scope tests.

Table 4.7. Experimental Design in the Krupnick et al. (2001) and Alberini et al. (forthcoming) studies

Risk reduction to be valued	Wave 1	Wave 2
I	5 in 1000 over 10 years	1 in 1000 over 10 years
II	1 in 1000 over 10 years	5 in 1000 over 10 years
III	5 in 1000 over 10 years, starting at age 70	5 in 1000 over 10 years, starting at age 70

Bid amounts for both studies are shown in table 4.8.

Table 4.8. Bid Values in the Krupnick et al. (2001) and Alberini et al. (forthcoming) studies.

	Initial bid	If yes	If no
US (2000 US dollars)	70	150	30
	150	500	70
	500	725	150
	725	1000	500
Canada (1999 Canadian dollars)	100	225	50
	225	750	100
	750	1100	225
	1100	1500	750

Figures 4.1 and 4.2 display the percentages of “yes” responses to the initial payment questions by country and by risk reduction. Three patterns emerge from these figures. First, respondents behave as expected, in that the percentage of “yes” responses declines with the bid amount. This is true for both risk reductions and both countries. Second, the proportion of “yes” responses is lower for the smaller risk reduction at all bid values, implying that WTP for the smaller of the two risk reductions should be smaller. Third, there is a considerable similarity between the two countries, which suggests that WTP figures may be statistically indiscernible once one accounts for the exchange rate and/or purchasing power parity.

Descriptive statistics of the Canadian and US samples are shown in table 4.9 and 4.10.

Table 4.9. Krupnick et al. Canada study, Cleaned Data,* Wave 1. N=616.

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Age	616	53.97	10.21	40.00	75.00
Male dummy	616	0.47	0.50	0	1
Education	616	13.75	2.98	0	18.00
Annual household Income (Can \$)	605	58923.14	36401.88	12000	175000
Chronic illness**	616	0.41	0.49	0	1

* Respondents who failed the probability quiz and prefer to be person with higher risk of dying are excluded from the sample.

** Any of cardiovascular diseases, high blood pressure, asthma, chronic bronchitis or emphysema, other chronic illnesses.

Table 4.10. Alberini et al. US data, Cleaned data,* Wave 1.

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Age	571	55.66	11.45	40	80
Male dummy	567	0.48	0.50	0	1
African-American dummy	571	0.09	0.29	0	1
Education	569	13.07	2.35	8	21
Annual household Income (US \$)	498	53338.35	30645.31	5000.00	130000
Chronic illness**	567	0.51	0.50	0	1

* Respondents who failed the probability quiz and prefer to be person with higher risk of dying are excluded from the sample.

** Any of cardiovascular diseases, high blood pressure, asthma, chronic bronchitis or emphysema, other chronic illnesses.

Krupnick et al. use a “spike model” (i.e., the mixed continuous/interval data version of a tobit) to model the responses to the payment questions in the Canada study, but Alberini et al. (forthcoming) use only the responses to the initial and follow-up questions and estimate a double-bounded model of WTP based on the Weibull distribution. This model does not admit zero WTP responses. Even those respondents who announced they were not willing to pay anything at all are ascribed a positive WTP amount between zero and the lowest bid they were queried about.¹⁴

¹⁴ In the Canada study, zero WTP responses were reported by 19.5% of wave 1 for the 5 in 1000 risk reduction, and 36.8% of wave 2 for the 1 in 1000 risk reduction. The corresponding relative frequencies for the US are 22.0% and 37.7%.

WTP increases significantly with the size of the risk reduction and is lower for the future risk reduction. The Canada study finds that WTP is about 30% lower for the oldest age group (70 year-olds and older). A decline of similar magnitude—but statistically insignificant—is also seen with the US data. The data from these studies also suggest that there is no particular reason to believe that people with chronically impaired health are willing to pay less for a risk reduction: In Canada, for example, people with cancer are actually willing to pay *more*. Finally, WTP for a future risk reduction is lower than WTP for a contemporaneous risk reduction, implying discount rates of about 8 percent in the Canada and 4.5 percent in the US.

Figure 4.1. Percent of “yes” responses by bid value: Canada study

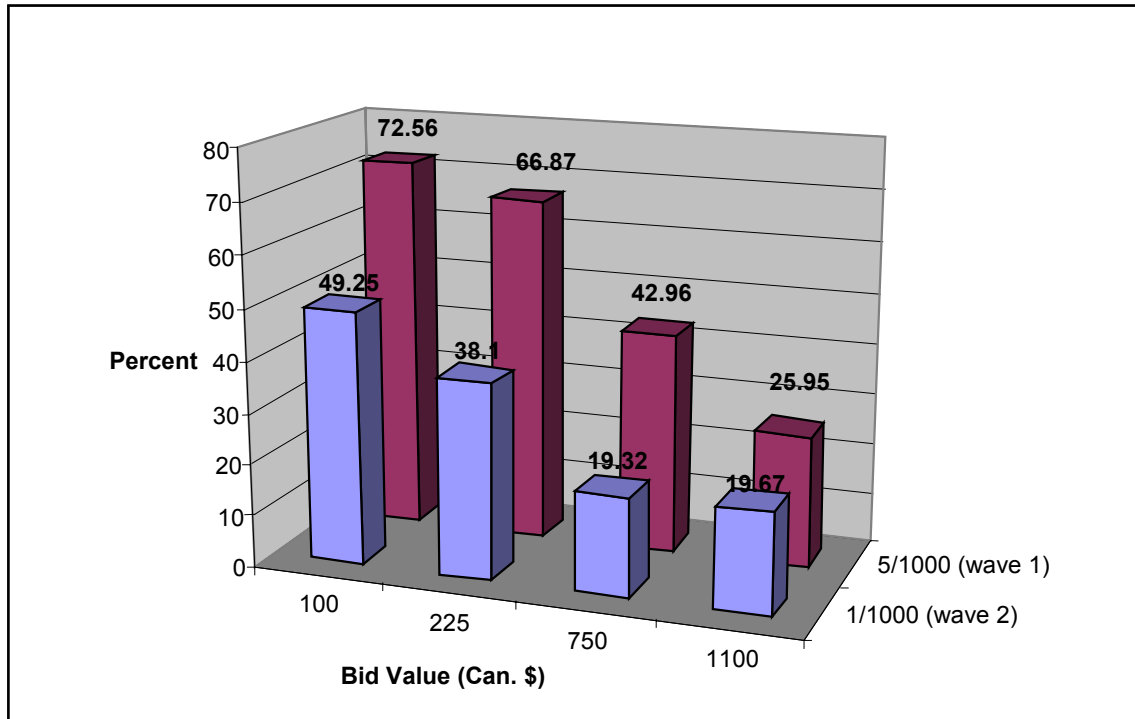
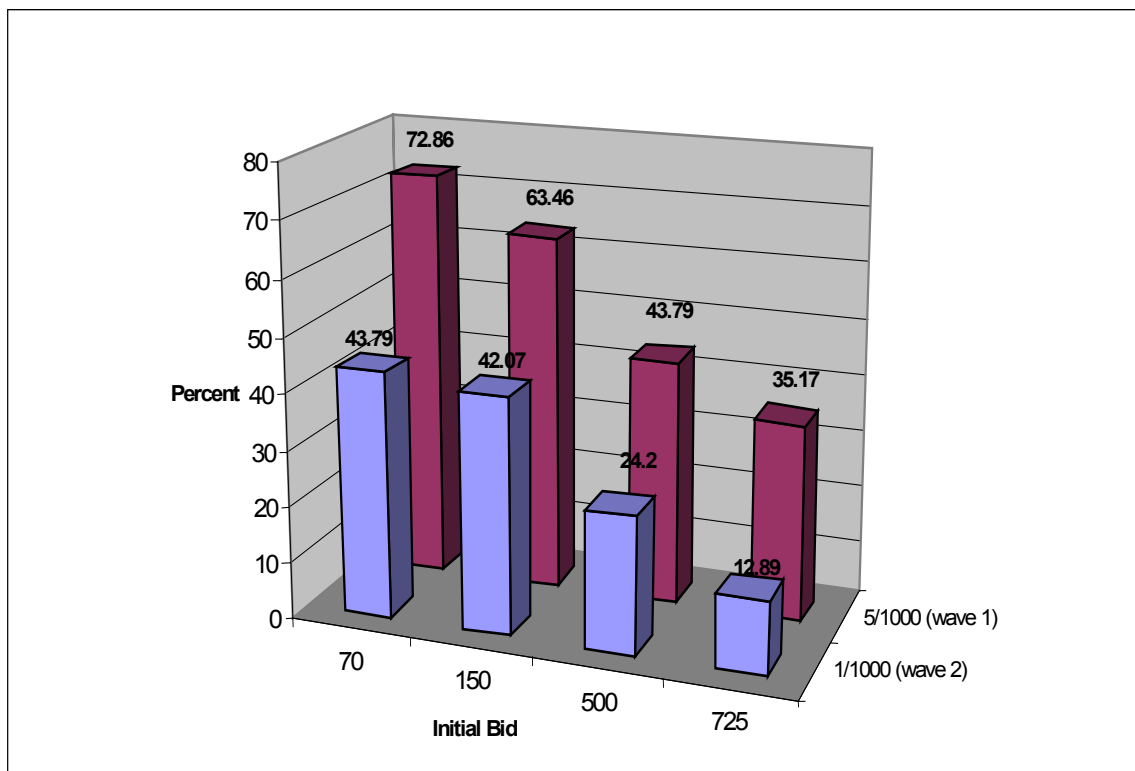


Figure 4.2. Percent of “yes” responses by bid value: US Study.



E. Persson et al. study

Persson et al (2001) report on a mail survey eliciting WTP for reductions in the risk of dying in a road-traffic related fatality. The survey was conducted in Sweden in Spring of 1998. Questionnaires were mailed to a representative sample of Swedes of ages 18-74. The first mailing (N=5650) took place in March 1998. The recipients of this mailing were sent two reminders, and a total of 2884 questionnaires were returned, for a response rate of about 51%. The researchers also sent a total of 2645 “drop out” questionnaires, 659 of which were filled out and returned. The purpose of these “drop out” questionnaires was to investigate possible self-selection of respondents into the final sample.

Two major versions of the questionnaire were created. The first version focuses on the risk of dying in a road traffic accident, while the second focuses on the risk of experiencing non-fatal injuries. The article, however, focuses on the 935 completed questionnaires about fatal risks.

The survey instrument (see Appendix B) begins with questions about the respondent's gender, age, household composition, and access to a car. It continues with questions attempting to establish the respondents' behaviors in terms of traffic safety, such as use of helmets when bicycling and seat belts when driving. Detailed questions about driving a car, riding a bicycle, walking and using public transit follow. At the end of this section, respondents are asked if they were ever injured in a traffic incident, whether this accident was in the last year, and whether any family members have ever been in an accident.

In order to assess health status, the respondents were shown a thermometer-like scale with values ranging from 0 to 100, where 0 represents the worst possible condition and 100 represents the best possible condition. Respondents were asked to indicate on the scale the number corresponding to their current health.

The next section of the questionnaire introduces the risk of dying, the risk communication device being a grid of squares. Risks are expressed as X in 100,000, and as an example people are shown the risks of dying for various causes (all causes, heart disease, stomach or esophageal cancer, traffic accident) for a 50-year-old. Respondents are then asked to assess their subjective risk of dying for any cause, and to report their WTP for a reduction in this risk in an open-ended format.

The risk reduction is expressed as a proportion (10%, 30%, or 50%, depending on the questionnaire version; see table 4.11) of the baseline risk. The risk reduction is a private commodity (safety equipment and preventive health care) and is valid for one year at the time. A reminder of the respondent's budget constraint is provided.

The questionnaire moves on to the risk of dying in a road-traffic accident. The respondent is asked to assess his or her own risk of dying in a road-traffic accident, after giving due consideration to age, miles driven, and care taken with driving. The risk reduction is private, and is delivered by safety equipment, and subject to the same limitations, caveats

and open-ended format as the previous WTP question. It should be kept in mind that respondents who were previously asked to value 10% and 50% reductions in their risk of dying for any cause are also asked to value 10% and 50% reductions, respectively, in their risk of dying in a traffic accident. Those respondents that were previously assigned a 30% reduction in the risk of dying for any cause are asked to consider 30% or 99% reductions in their risk of dying in a traffic accident, with random assignment to the 30% or 99% risk reduction (see table 4.11).

Table 4.11. Experimental design for the mortality risk version of the Persson et al. study (2001).

	Proportional reduction in the risk of dying in a traffic accident			
	10% risk reduction	30% risk reduction	50% risk reduction	99% risk reduction
Mailings (N=3050)	250	2300	250	250
Returned questionnaires (N=960)	112 (11.67 of usable sample) (44.8% of mailings)	566 (58.96% of usable sample) (24.60% of mailings)	181 (18.85% of usable sample) (72.4% of mailings)	101 (10.52% of usable sample) (40.4% of mailings)

Persson et al. investigate sample selection issues, finding that their sample has higher income, education, and miles driven per year than both the population of Sweden and the people that did not return the questionnaire but filled out the “drop out” card. Access to a car and gender in the sample are roughly the same as for the population at large, but women decline to fill out the questionnaire more often than men.

Descriptive responses of the sample with valid WTP observations for mortality risk reductions are displayed in table 4.12.

Table 4.12 Descriptive statistics, Persson et al. study (N=977: respondents who answer the mortality risk WTP questions.)

Variable	Valid observations	Mean	Standard deviation	Minimum	Maximum
Male (dummy)	977	0.56	0.49	0	1
Age	976	43.25	14.29	17	74
Income (SEK)	953	146,855.72	82,969.70	7,194.24	603,448.28
DEGRISK (subjective mortality risk in road traffic accident)	960	65.62	1614.81	0	50,000
kilometers driven in a car per year	943	14,075.4	7,639.9	4,999.37	27,495
Ever been injured in an accident (dummy)	977	16.94	37.53	0	1
High school education (dummy)	977	0.45	0.50	0	1
College education (dummy)	974	0.17	0.47	0	1

Persson et al. extrapolate WTP to the population by using the estimated income elasticity of WTP, but their econometric models do not explicitly control for self-selection into the sample using information from those respondents who filled the “drop out” card and did not return the questionnaire. We were not able to obtain these additional data from them.

To compute WTP and the VSL, since the baseline risk is different for different respondent, Persson et al run regressions relating (log) WTP to baseline risks, the size of the risk reduction, access to a car, experience with accidents, income and age. This results in estimates of VSL that vary with the size of the absolute risk reduction, a result that is in contrast with the assumption made by many agencies and practitioners that there is a single VSL.

F. Summary

This chapter has presented the studies that will be examined in more detail in the remainder of this report. Table 4.13 shows in which chapters the data from the various studies are analyzed econometrically to investigate the robustness of WTP with respect to various criteria.

Table 4.13. Data analyses in the remainder of the report.

Study	Chapters (topic of the analysis)
Johannesson et al. (1997)	Chapter 5 (sensitivity of welfare estimates to distributional assumptions for WTP, procedure for computing mean); Chapter 6 (identification and removal of outliers)
Johannesson and Johannesson (1996)	Chapter 5, Appendix (sensitivity of welfare estimates to distributional assumptions for WTP, procedure for computing mean); Chapter 7 (discrete mixtures)
Gerking et al. (1988)	Chapter 8 (interpretation of WTP responses); Chapter 9 (endogeneity of risk and WTP) Mentioned in chapter 10 (self-selection into the sample)
Krupnick et al. (2002)	Chapter 7 (discrete mixtures); Chapter 8 (interpretation of WTP responses)
Alberini et al. (forthcoming)	Chapter 6 (outliers); Chapter 7 (discrete mixtures); Chapter 10 (self-selection into the sample)
Persson et al. (2001)	Chapter 6 (outliers); Chapter 9 (endogeneity of risks and WTP); Mentioned in chapter 10 (self-selection into the sample)

5. SENSITIVITY OF WELFARE ESTIMATES TO THE DISTRIBUTION OF WTP

In this section, we examine the issue of the sensitivity of the WTP estimates to the assumptions about the distribution of WTP and the procedure used for computing the welfare statistics. As the analysis and modeling of the data rest on these assumptions when information about WTP is elicited using dichotomous choice payment questions, we use the Johannesson et al. (1997) dataset. (All calculations and estimation runs are repeated with the Johannesson and Johansson (1996) data. Results for the latter dataset are reported in an Appendix to this chapter.)

A. Basic Data Checks and Changing the distribution of WTP

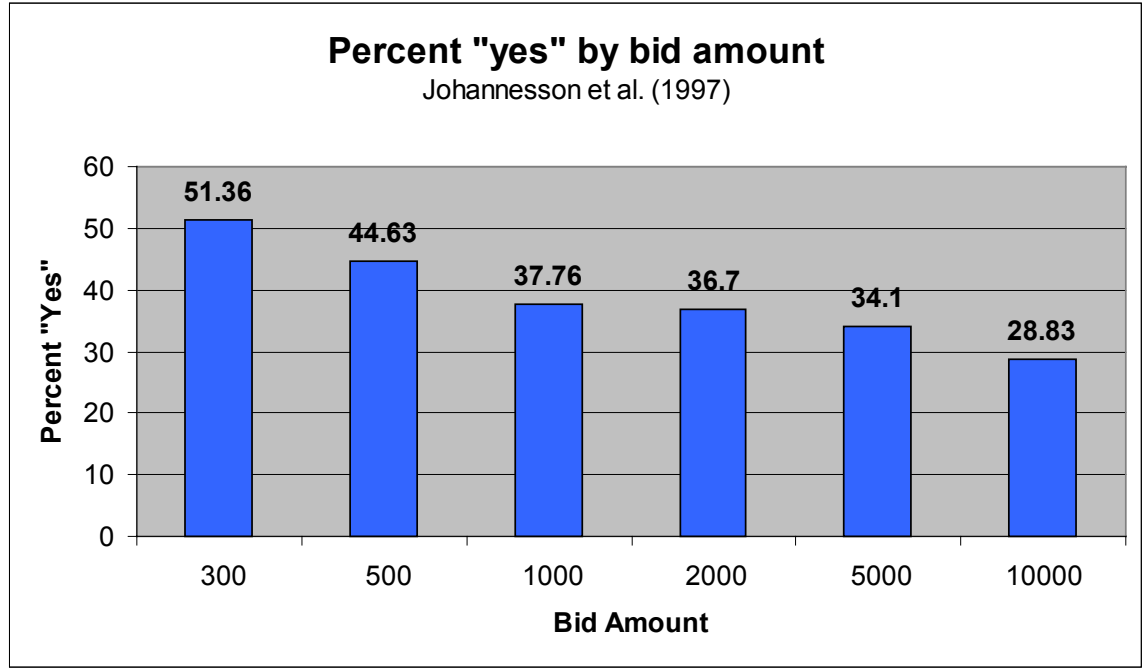
In this section, we examine the sensitivity of the estimates of WTP (and hence VSL) based on dichotomous choice data to the WTP distribution and to the procedure used by the researcher in computing mean WTP. To illustrate the consequences of assumptions and procedures, we used the data in Johannesson et al. (1997). Johannesson et al. surveyed Swedes aged 18-74 over the telephone about their WTP for a 2-in-10,000 reduction in their risk of dying over the next year.

The payment question reads as follows: “It is estimated that X(Y) men (women) out of 10,000 in the same age as you will die during the next year. Assume that you could participate in a preventive and painless treatment which would reduce the risk that you will die during the next year, but has no effects beyond that year. The treatment reduces the risk of your dying during the next year from X(Y) to X-2 (Y-2) out of 10,000. Would you at present choose to buy this treatment if it costs SEK I?”

Respondents were given two response categories, “yes” and “no.” The bid values ranged between 300 and 10,000 SEK (about \$40 to \$1400, implying VSL values of \$200,000 to \$7 million). Johannesson et al. estimate mean WTP to be 6300 SEK, or about \$900.

When dichotomous choice questions are used, it is important that (i) the percentage of “yes” responses decline with the bid amount, and that (ii) the bids cover a reasonably wide portion of the range of WTP values. As shown in Figure 5.1, the percentage of “yes” responses declines from 51.36% at the lowest bid amount, 300 SEK, to 28.83% at the higher bid amount 10,000 SEK, satisfying the first of these two requirements. The figure also implies that the bids barely hit median WTP, and cover mostly the upper tail of the WTP range, failing to satisfy requirement (ii), and raising concerns about the stability of the WTP estimates of WTP. Median WTP should be between 300 and 500 SEK.

Figure 5.1.



B. Changing the Distribution of WTP

We use the data from Johannesson et al. to fit binary-response models of WTP based on four alternative WTP distributions. These distributions are the normal, logistic, lognormal and Weibull, which are commonly used to represent latent WTP in empirical analyses of dichotomous choice CV data. Mean and median WTP are derived directly from the estimated parameters of the binary-response models, using the properties of the distributions being used.¹⁵ Results are reported in table 5.1.

¹⁵ For example, if it is assumed that WTP follows the normal (logistic) distribution, one fits a probit (logit) model, regressing a dummy for the “yes” or “no” responses to the payment question on the intercept and the bid. As shown by Cameron and James (1987), mean/median WTP is equal to $-\alpha/\beta$, where α is the intercept and β is the coefficient on the bid in the probit (logit) model. We use the delta method (see Cameron, 1991) to obtain the standard error around mean WTP. Using a symmetric distribution implies that mean WTP is equal to median WTP, a requirement that is relaxed when the Weibull and log normal distributions are used. In the case of the Weibull distribution, the probability that a respondent says “yes” to a dichotomous choice payment question is $\text{Prob}(\text{yes}|B_i) =$

$\exp\left\{-\left(\frac{B_i}{\sigma}\right)^\theta\right\}$, and the probability that the respondent answers “no” is one minus this

quantity. Mean WTP is equal to $\sigma \cdot \Gamma(1/\theta + 1)$, and median WTP is $\sigma \cdot (-\ln(0.5))^{1/\theta}$.

The most surprising result of table 5.1 is that the estimates of mean and median WTP are *negative* when the normal and logistic distributions are used. In fact, the model based on the normal distribution predicts that 54% of the respondents will have negative WTP values. Using the Weibull and lognormal distributions, which admit only non-negative values of WTP and fit the data better, circumvents this problem, but results in a large discrepancy between median and mean WTP, and in very large estimates of mean WTP.¹⁶

Using the Weibull distribution, for example, mean WTP is two orders of magnitude greater than median WTP. The median WTP amount predicted by the two distributions is similar (239 and 250 SEK for Weibull and lognormal, respectively), but less than what would be inferred by examining the responses to the payment questions, and less than the smallest bid value offered to the respondents in the study, which raises doubt about the fit of the estimated survival curve.

Based on the log likelihood function, the binary response model based on the lognormal distribution has the best fit; the probit and logit models fare much worse. As mentioned, however, choosing to work with the lognormal distribution for WTP, results in implausibly large estimates of mean WTP, a result that does not change when one turns to the Weibull distribution.¹⁷

When latent WTP is a lognormal, $\text{Prob}(\text{yes}|B_i) = \Phi(\mu / \sigma - \ln B_i / \sigma)$, where μ is the mean of the logarithmic transformation of WTP, and σ is its standard deviation. Mean WTP is $\exp(0.5\sigma^2 + \mu)$, and median WTP is equal to $\exp(\mu)$.

¹⁶ This is probably due to two concurrent factors. The first is that the estimate of mean WTP depends crucially on the upper tail of the distribution of WTP, corresponding to high bid values. The second is that in this study the bid placement is unbalanced, with virtually all bid amounts on the right of the median. In a Monte-Carlo simulation exercise, I found that when the distribution of the underlying WTP variable is skewed, using a design that covers only a limited portion of the range of WTP (e.g., all the bid values are to the left of the median, or to its right) can bring biases on the estimates of mean/median WTP and is potentially grossly inefficient. The problem appears to be particularly severe when the underlying distribution of WTP has a relatively large variance.

¹⁷ An alternative measure of fit frequently used with binary data model is the percentage of correctly predicted observations. This percentage is equal to 61.3% for probit, logit, and the binary model corresponding to the lognormal distribution for latent WTP, and about 60.6% for the Weibull model. These percentages are disappointing low, when compared with researchers' expectations for binary data regressions, although probably not very different from binary regressions based on CV data on environmental quality and amenities.

Table 5.1. Mean and Median WTP for various distributional assumptions
(Johannesson et al. study, 1997)

	Normal (probit model)	Logistic (logit model)	Weibull	Lognormal
Mean WTP	-2096.08	-2007.75	2,894,292	Infinity
Median WTP	-2096.08	-2007.75	238.39	254.30
Log L	-1349.19	-1349.10	-1344.01	-1343.84

Clearly, these WTP figures are very different from those reported by Johannesson et al. (1997), because the latter rely on a completely different procedure for estimating mean WTP. They start with fitting a logit model of the responses, which assumes that WTP follows the logistic distribution and implicitly admits negative WTP values, but mean WTP is computed as the area under the survival curve over the *positive* WTP values, i.e., from 0 to infinity. When WTP is a logistic variate, this area is equal to $(-1/\beta)\ln[1 + \exp(\alpha)]$, where α is the intercept and β is the slope of the logit model. Formally,

$$\begin{aligned}
 (5.1) \quad \int_0^{+\infty} \Pr(WTP > B) dB &= \int_0^{+\infty} \frac{\exp\{(\alpha + \beta B)\}}{1 + \exp\{(\alpha + \beta B)\}} dB = \frac{1}{\beta} \int_0^{+\infty} \frac{(\beta) \exp\{(\alpha + \beta B)\}}{1 + \exp\{(\alpha + \beta B)\}} dB \\
 &= \frac{1}{\beta} [\ln(1 + \exp\{(\alpha + \beta B)\})]_0^{+\infty} = \left(-\frac{1}{\beta}\right) \cdot \ln(1 + \exp(\alpha)),
 \end{aligned}$$

where β is negative. Expression (5.1) is analogous to mean WTP from a tobit model, except that Johannesson et al. did not estimate a tobit model, and their sample does not contain zeros.

Regarding the fact that estimated median WTP is less than the smallest bid assigned to the respondents in the survey, it is useful to compare the predicted probabilities of a “yes” response for various bid levels under different distribution assumptions, as we do in table 5.2.

Table 5.2. Probabilities of “yes” to the bid amounts (Johannesson et al. study, 1997).

Bid amount (SEK)	Relative frequency of “yes” responses in the sample	Probability of “yes” predicted by normal model	Probability of “yes” predicted by Weibull model	Probability of “yes” predicted by lognormal model
300	51.36	45.23	48.78	49.00
500	44.63	44.84	45.88	45.87
1000	37.76	43.85	41.88	41.68
2000	36.70	41.89	37.81	37.58
5000	34.15	36.14	32.43	32.37
10000	28.36	27.27	28.42	28.64

Table 5.2 shows that all of the three parametric models used (probit, Weibull and lognormal) fit the data poorly at the lowest bid values. They all predict median WTP to be less than 300 SEK, although inspection of the empirical relative frequencies of the “yes” responses suggests that median WTP should be between 300 and 500 SEK.

C. Changing the procedure for estimating mean WTP

In table 5.3, we experiment with alternative approaches for calculating mean WTP, focusing on four procedures. The first procedure follows Cameron and James (1987), fitting a probit or logit model and computing mean WTP as

$$(5.2) \quad m_1 = -\alpha / \beta.$$

The second is the procedure used by Johannesson et al., who fit a logit model but effectively disregard the portion of the distribution corresponding to negative values. As explained, with the logistic distribution this results in the following expression:

$$(5.3) \quad m_2 = (-1 / \beta) \ln[1 + \exp(\alpha)].$$

Our third procedure relies on the fact that mean WTP is the area under the survival curve, i.e., $[1 - F(\alpha + \beta y)]$. In earlier applications of the CV method, researchers estimated mean WTP by computing the area under the survival curve until the largest bid amount offered in the survey (e.g., 10,000 SEK in the Johannesson et al. study). Our third estimate of mean WTP is thus:

$$(5.4) \quad m_3 = \int_0^{B_{\max}} [1 - F(\alpha + \beta y)] dy.$$

Finally, Chen and Randall (1997) and Creel and Loomis (1998) describe semiparametric approaches for estimating mean WTP. Specifically, they propose to estimate m_3 as in

equation (5.4), but improve the fit of $F(\bullet)$ through adding terms such as the sine and cosine transformations of the bid and of other regressors in its argument, in the spirit of fast Fourier transforms approximations.¹⁸ The argument of $F(\bullet)$, therefore, becomes:

$$(5.5) \quad z = \mathbf{x}\beta + \sum_{\alpha=1}^A \sum_{j=1}^J [u_{j\alpha} \cos(j\mathbf{k}_{\alpha}s(\mathbf{x})) - v_{j\alpha} \sin(j\mathbf{k}_{\alpha}s(\mathbf{x}))],$$

where \mathbf{x} is a vector that includes the bid and determinants of WTP. For a subset, or all, of these variables (the dimension of this subset being A), we introduce a scaling function $s(\mathbf{x})$. This scaling function subtracts the minimum value of \mathbf{x} , divides the result by the maximum value of \mathbf{x} (thus forcing the rescaled variables to be between zero and 1), and then multiplies by $(2\pi - 0.00001)$. For this rescaling function to be possible, there must be at least three distinct values for \mathbf{x} , which rules out applying this transformation to dummy variables. The quantities \mathbf{k} and u are vectors of indices and parameters to be estimated, respectively. Chen and Randall (1997) and Creel and Loomis (1998) suggest that for most dichotomous choice CV survey applications it is sufficient to consider $J=1$, which simplifies z to:

$$(5.6) \quad z = \mathbf{x}\beta + \sum_{\alpha=1}^A [u_{\alpha} \cos(s(\mathbf{x})) - v_{\alpha} \sin(s(\mathbf{x}))].$$

We apply the semiparametric approach defined by equation (5.6) to the Johannesson et al. data, and compute mean WTP, m_4 , by integrating the survival function under the curve up to the largest bid used in the study. We choose $F(\bullet)$ to be the standard logistic and standard normal cdf, respectively, in two alternate runs, and specify z to include the intercept, the bid, and its sine and cosine transformations (after rescaling):

$$(5.7) \quad \int_0^{B_{\max}} [1 - F(\alpha + \beta y + \delta \sin(y') + \gamma \cos(y'))] dy,$$

where $y' = (2\pi - 0.00001) \cdot \left[\frac{y - B_{\min}}{B_{\max}} \right]$, where B_{\min} and B_{\max} are the smallest and largest bid values used in the survey.

The results from these alternative calculations of mean WTP are shown in table 5.3. The table shows that the largest jump in estimated mean WTP occurs when going from m_1 —which yields a negative mean WTP—to approaches m_2 - m_4 , which restrict integration to the positive semiaxis (or a portion of it). Within the latter, however, the estimates of mean WTP are within about 10% of one another, regardless of using exact expressions or numerical integration, and normal or logistic $F(\bullet)$.

¹⁸ Chen and Randall also consider polynomial terms in the variables \mathbf{x} .

Table 5.3. Different procedures for computing mean WTP. Johannesson et al. (1997) data.

<u>Approach</u>	<u>Distribution F()</u>	<u>Mean WTP (in SEK)</u>
Cameron and James (1987): m_1	Logistic	-2007
Johannesson et al., closed-form expression: m_2	Logistic	6849
Numerical integration of the survival function up to max bid: m_3	Logistic	6485
Numerical integration of the survival function up to max. bid: m_3	Normal	6319
Creel and Loomis (1998) semiparametric approach: m_4	Logistic; logit model with bid, sin(bid) and cos(bid)	6472
Creel and Loomis (1998) semiparametric approach: m_4	Normal; probit model with bid, sin(bid) and cos(bid)	6254

C. Focus on the regressors

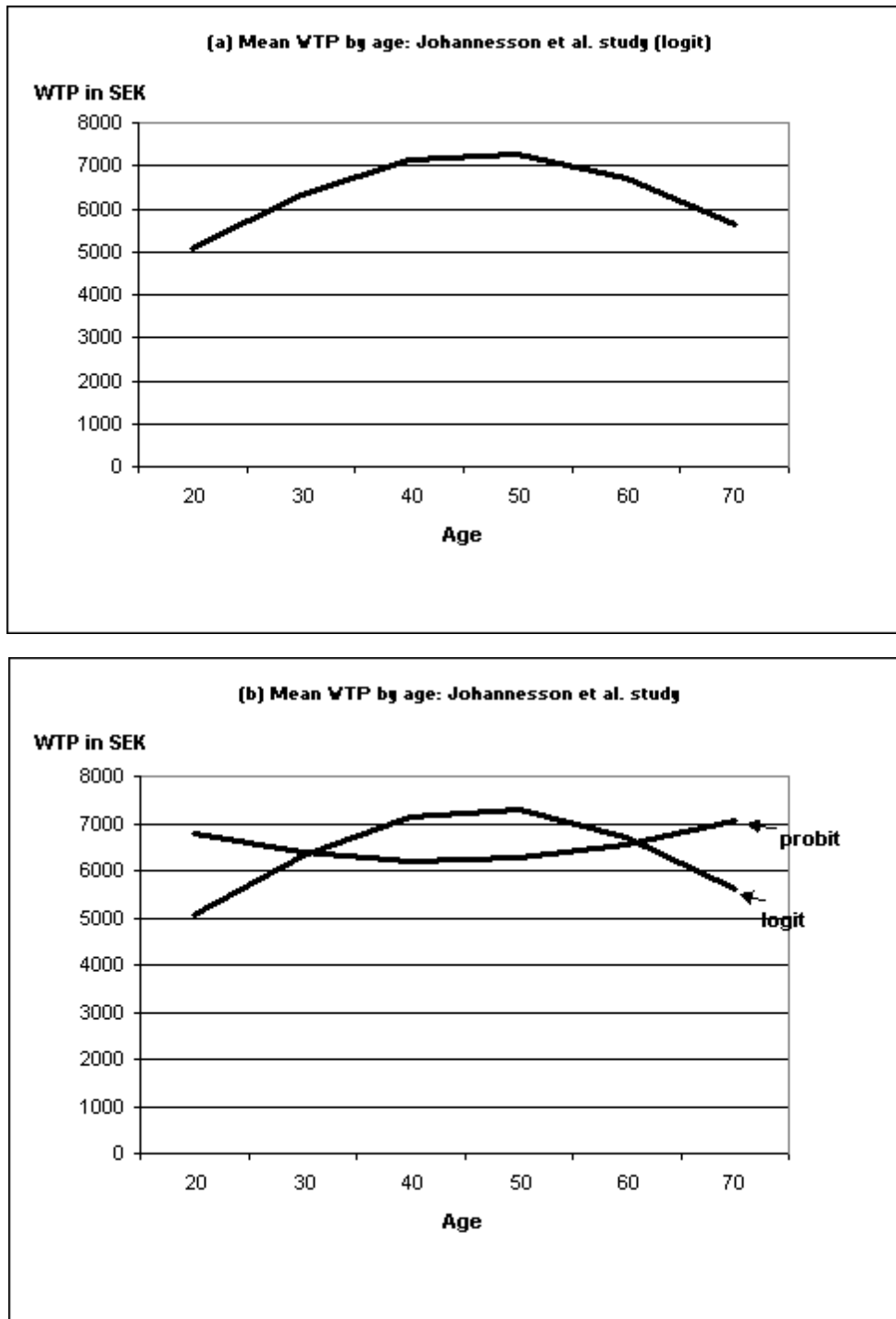
Would similar results be obtained in the situation where regressors are included in the model, and mean WTP is calculated for specific values of the regressors? This question is appropriate, for example, when seeking to answer the question of how WTP for a risk reduction varies with age. In policy analyses, some observers have suggested that older people should be willing to pay less for a risk reduction, and hence their VSL should be lower, reflecting their fewer remaining life years. Economic theory, however, does not offer unambiguous predictions about the effect of age on WTP (Alberini et al., forthcoming).¹⁹

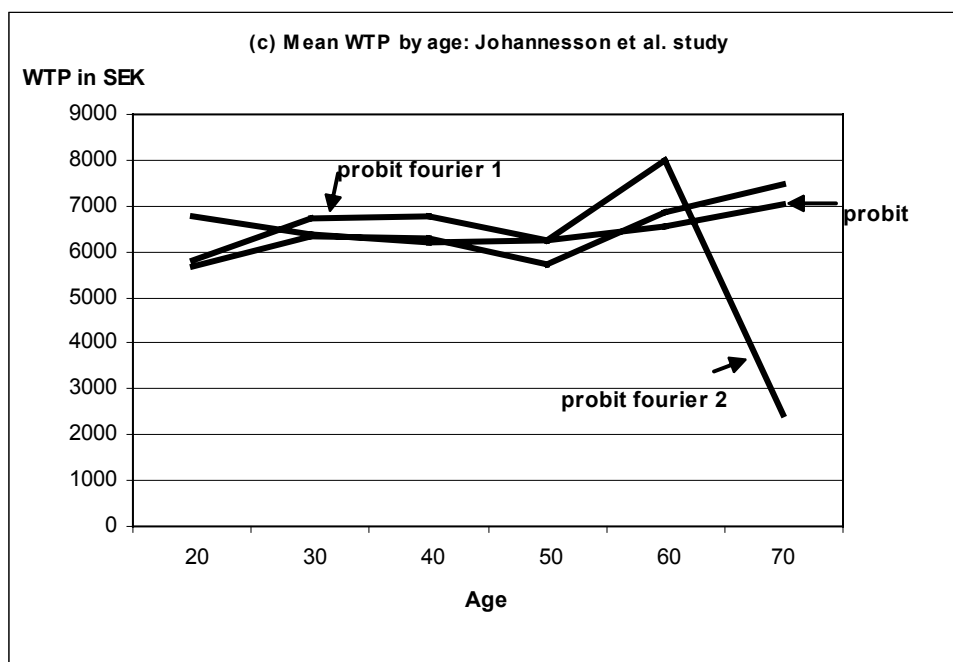
Johannesson et al. run a logit regression that includes age and age squared, plus gender and education dummies, income and the respondent's quality-of-life rating, and report finding a quadratic relationship between age and WTP that peaks when the individual is about 40-50 years old. To check the sensitivity of these results to the procedure used in the calculation, we ran logit and probit models with the same regressors, and predicted mean WTP at different ages using approaches m_2 , m_3 , and m_4 above.

¹⁹ Because a large proportion of the lives saved appear to be those of the elderly, there has been much recent debate whether the VSL should be lower for the elderly to reflect their fewer remaining life years. In the US, the Office of Management and Budget recently repudiated making such adjustment for age, on the grounds of insufficient evidence that VSL is lower for elderly persons (Skrzycki, 2003; Office and Management and Budget, 2003).

The results of these calculations are shown in Figure 2, panels (a)-(c). Panel (a) shows that using m_2 with the logit distribution—the same formula used by Johannesson et al.—confirms their findings: the relationship between age and WTP is an inverted U that peaks at age 50. However, when the logit model is replaced by a probit model, the relationship changes entirely, becoming a U-shaped curve.

Figure 5.2.





Legend: Logit or probit = logit or probit that integrate (1-cdf) from zero to infinity;
 Fourier 1 = bid, age and age squared + fourier terms for bid, age and age squared
 Fourier 2 = bid, age and age squared, income and quality of life, sex and education dummy, plus fourier terms for bid, age and age squared. In Fourier 1 and 2 integration is to the largest bid amount.

When applying the semiparametric approach, m_4 , we experiment with two specifications. The first fits a probit model with the intercept, the bid, age and age squared, and their sine and cosine transformations (after rescaling). The second further includes gender and education dummies, income and the quality-of-life rating, and the sine and cosine transformations of all continuous variables (after rescaling). The predictions shown in Figure 1, panel (c) refer to a male (SEX=1) with high school education (DEDU=1). Panel (c) suggests that there is no easily discernible pattern, and that claims about the quadratic relationship are not robust, and may simply be an artifact of restrictive assumptions.

We further investigate this matter by considering a simpler model where the only covariates are age and age squared, switching to a lognormal distribution for WTP, and predicting median WTP for specific ages, which should result in more conservative estimates.²⁰ The results are shown in table 5.4. Two major points emerge from this table.

²⁰ Specifically, I assume that $\log WTP = \mathbf{x}_i \beta + \varepsilon_i$, with ε a normally distributed error term, and \mathbf{x} a vector of covariates. This is an accelerated life model. The mapping between the latent WTP and the observed response to the payment question is, as usual, that the respondent answers “yes” if his or her unobserved WTP amount (log WTP) is greater

First, using median WTP, which is a robust lower-bound estimate of welfare change, results, as expected, in much lower WTP and VSL estimates. Second, the lognormal model results in a quadratic, inverted-U relationship between age and WTP with the highest WTP at age 40. However, the lognormal model and the use of median WTP suggest that the curvature of the relationship is *much sharper* than that predicted by the Johannesson et al. approach.²¹ For example, the WTP of a 70-year-old for a reduction in risk of 2 in 10,000 is only 90 SEK, or about 20% of the WTP predicted for a 40-year-old person (440 SEK). By contrast, in Johannesson et al. the WTP of a 70-year-old is only about two-thirds that of a 40-year old.

Table 5.4. The relationship between age and WTP for a risk reduction:
lognormal WTP and median WTP v. Johannesson et al. logit and truncated mean WTP.

Age	Johannesson et al, 1997.		Alternative calculation using log normal WTP.	
	Mean WTP in SEK	Implied VSL in million SEK	Median WTP in SEK	Implied VSL in million SEK
20	6100	30.3	137.18	0.672
30	6900	34.6	307.31	1.505
40	7200	36.1	440.77	2.160
50	6900	34.3	404.75	1.983
60	6000	29.8	237.97	1.166
70	4600	23.3	89.57	0.439

While inference about the general *shape* of the relationship between age and WTP is confirmed by the alternative calculations, this exercise also illustrates that the extent to which WTP changes with age depends crucially on the assumptions underlying the model.

than the bid (log bid), and “no” otherwise. The corresponding binary data model is a probit where $\log \text{bid}$ enters as an additional regressor. Formally, $\Pr(I_i = 1) = \Phi(x_i \beta / \sigma - \log B_i / \sigma) = \Phi(x_i \alpha + \gamma \log B_i)$, where I is an indicator that takes on a value of one if the response is “yes.” The estimated α coefficients from probit model (3) are 0.3005 (intercept), 0.0293 (age), -0.00034 (age squared), while γ is pegged at -0.1525.

²¹ The logit regression controls for age, and finds evidence of an inverted-U shaped relationship between age and WTP. The mean WTP values for persons of various ages are computed as $(-1/\beta) \ln[1 + \exp(\alpha_j)]$, where j denotes age in years, $\alpha_j = \alpha_0 + \alpha_1 \cdot j + \alpha_2 \cdot j^2$, and the α s are the coefficients from the logit regression.

Conclusions

- This section examine the effects of distributional assumptions, choice of WTP welfare statistic, and procedure used for calculating such a statistic, when the VSL is estimated from dichotomous choice WTP responses. Using the data from the Johannesson et al. (1997) study as an example, I show that changing the distributional assumption can result in dramatic changes in VSL.

- While treating WTP as a normal or logistic variate may result in negative estimated mean WTP figures, distributions of WTP defined over the positive semiaxis can, in some cases, produce estimates of mean WTP that are, depending on the data and the distribution used, orders of magnitude larger than median WTP. These problems are often seen in dichotomous choice contingent valuation surveys, and are not specific to the mortality risk context.

- It is useful to compare alternative calculations of mean WTP. For example, this section examined (i) the logistic closed-form expression for the area under the survival function, (ii) numerical integration, (iii) numerical integration to the largest bid, (iv) semiparametric estimation of the survival function plus numerical integration to the largest bid, finding that, with the Johannesson et al. data, they give similar results when covariates are not included. By contrast, the functional form of the relationship between a key covariate—the age of the respondent—is extremely sensitive to the procedure used, to the point that not much can be said about the relationship between age and WTP, which Johannesson et al. previously claimed to be quadratic.

- Median WTP is a robust welfare statistic.

In the next section, I examine whether detection of potential outliers mitigates the problems mentioned above.

Appendix.

Johannesson and Johannesson (1996) observe “yes” or “no” responses to a dichotomous choice question about a life expectancy extension of one year at the age of 75, and fit a logit model to these responses. The model assumes that WTP follows the logistic distribution, and posits that:

$$(A.1) \quad \Pr(\text{Yes} \mid B_i) = \Pr(WTP_i > B_i) = \exp(\alpha + \beta \cdot B_i) / [1 + \exp(\alpha + \beta \cdot B_i)]$$

where $\alpha = \mu / \sigma$, $\beta = -1 / \sigma$, μ and σ are the location and scale parameter of WTP, and B denotes the bid amount assigned to the respondent. Here, μ is both mean and median WTP.

Johannesson and Johansson estimate mean WTP using the formula $(-1/\beta) \cdot \ln[1 + \exp(\alpha)]$, obtaining a figure of 8787 SEK.

Table A.1 presents the results of re-estimating binary data models of the responses to the payment questions under various distributional assumptions for latent WTP.

Table A.1. Mean and median WTP for different distributional assumptions about WTP. Johannesson and Johansson study (1996).

	Distribution			
	Normal (range: $-\infty$ to $+\infty$)	Logistic (range: $-\infty$ to $+\infty$)	Weibull (range: 0 to $+\infty$)	Log normal (range: 0 to $+\infty$)
Mean WTP (standard error)	-14222.35 (2362.35)	-11360.09 (2057.25)	50574.41 (27658.11)	2,092,389 (2,699,730)
Median WTP (standard error)	Same as mean WTP	Same as mean WTP	119.41 (32.93)	138.67 (29.69)
Log L	-1121.70	-1118.86	-1079.87	-1079.41

Table A.1 shows that symmetric distributions like the normal and logistic result in *negative* estimates of mean and median WTP, μ . If WTP is assumed to follow the Weibull or log normal distribution, both of which restrict WTP to be positive, mean and median WTP are, of course, positive. As is usually the case with these distributions, mean WTP is much greater than median WTP. Median WTP—a conservative but robust welfare statistic—is *almost two orders of magnitude* smaller than the estimate of mean WTP in Johannesson and Johansson (1996). By contrast, the estimates of mean WTP for the Weibull and log normal models are much larger than the figure obtained by Johannesson and Johansson, 8787 SEK.

Table A.1 also suggests that the log normal distribution provides the best fit, with the Weibull a close second. Mean WTP is, however, extremely large in the Lognormal model. Even for the Weibull model it is very large, showing that the estimates of mean WTP depend crucially on the distributional assumption made by the researcher. The lognormal and Weibull model produce similar estimates of median WTP (SEK 139 and 119, respectively).

To get a sense of the goodness of fit afforded by the various models, in table A.2 the relative frequencies of the “yes” responses are compared with the probabilities predicted by the various binary data models.

Table A.2. Probabilities of “yes” to the bid amounts (Johannesson and Johansson study, 1996).

Bid amount (SEK)	Percentage of “yes” responses	Probability of “yes” predicted by normal model	Probability of “yes” predicted by Weibull model	Probability of “yes” predicted by lognormal model
100	53.22	38.73	52.94	51.18
500	38.58	38.42	38.54	39.09
1000	31.38	38.04	32.69	33.74
5000	22.63	35.03	20.80	21.80
15000	13.64	27.95	14.40	14.68
50000	9.09	9.95	9.08	8.45

The probit model (corresponding to the assumption that WTP is normally distributed) estimates median WTP to be less than 100SEK, although the sample frequencies of “yes” responses imply that media WTP should be between 100 and 500 SEK. Moreover, it predicts virtually identical probabilities of a “yes” response for bid amounts between 100 and 1000SEK. The Weibull and lognormal models give predictions that are closer to the actual frequencies, and clearly outperform the probit and logit models.

6. OUTLIERS

In this section, we investigate the effect of outliers on the estimates of WTP. Collett (1991) defines as outliers “observations that are surprisingly far away from the remaining observations in the sample,” and points out that such values may occur a result of measurement errors, execution error (i.e., use of a faulty experimental procedure), or be a legitimate, if extreme, manifestation of natural variability.

In this section, we first examine criteria for considering a WTP response an outlier. Next, we examine WTP responses that could be considered outliers because of their WTP/income ratio. These observations are potentially suspect, and removing them could improve the fit of the binary data model, and/or result in a thinner upper tail of the observed distribution of WTP. We use the Johannesson et al., Alberini et al., and Persson et al. data to illustrate issues arising when identifying and excluding outliers. Additional examinations of the outliers problem are conducted in chapter 9, where we examine the effect of including and excluding observations with disproportionately large self-assessed baseline risks, and in section 7, where we discuss discrete mixtures containing nay-sayers, yea-sayers, and completely random responses to the payment question.

A. Outliers and Binary Data

How are outliers defined when the variable of interest is binary, as with the responses to dichotomous choice contingent valuation questions? Copas (1988) defines as an outlier an observation for which we predict a low (high) probability of a one (zero), but we do observe a one (zero).

What “high” and “low” means, of course, remains to be defined, and we use the Johannesson et al. (1997) data to check (i) how many observations could be classified as outliers according to several alternative cutoff levels, and (ii) by how much mean WTP would change if these outliers were excluded from the sample. Specifically, we wish to see how for how many observations the predicted probability of a “yes” was less than 0.05, 0.10, etc., but the response to the payment question was a “yes.” The predicted probability of a “yes” is based on Johannesson et al.’s logit regression of the “yes” or “no” response indicator on respondent age, age squared, income, an education dummy, and a quality of life rating subjectively reported by the respondent in the interview:

$$(6.1) \quad \hat{p}_i = \exp(x_i \hat{\alpha} + \hat{\beta} \cdot B_i) / [1 + \exp(x_i \hat{\alpha} + \hat{\beta} \cdot B_i)],$$

where $\hat{\alpha}$ and $\hat{\beta}$ are estimated coefficients, \mathbf{x} is a vector of regressors, and B is the bid assigned to respondent i . For ease of comparison, we use the same procedure for

estimating mean WTP as in Johannesson et al.'s work.²² Results are displayed in table 6.1.

Table 6.1. Outliers in the Johannesson et al. data (based on logit regression, n=1660).
All WTP figures in SEK.

Definition of outlier	How many?	Mean WTP (Johannesson et al. procedure)	Weibull: Mean WTP (in bold) and median WTP	Lognormal: Mean WTP (in bold) and median WTP
No outliers identified	None	6732 SEK	2.894 million 238	∞ 254
Prob(yes) \leq 0.05 and yes observed	None	6732 SEK	2.894 million 238	∞ 254
Prob(yes) \leq 0.10 and yes observed	None	6732 SEK	2.894 million 238	∞ 254
Prob(yes) \leq 0.20 and yes observed	5	6141 SEK	1.150 million 302	∞ 314
Prob(yes) \leq 0.25 and observed	26	4846 SEK	193,481 338	155 million 345
Prob(yes) \leq 0.30 and yes observed	59	3767 SEK	36,114 369	1.821 million 372

Table 6.1 shows that outliers according to the Copas' definition were found only when the cutoff for identifying an outlier was set to 0.20 or higher. When the cutoff is set to 0.25, for example, a total of 26 people would be considered outliers, and dropping them from the usable sample would reduce mean WTP to 4846 SEK—roughly a 40% reduction. An even larger decline in mean WTP would be observed if we dropped those respondents whose predicted likelihood of a “yes” response is less than or equal to 0.30, but were still observed to say “yes.”

Excluding outliers from the usable sample—even just a few at a time—also has a large effect on the welfare statistics resulting from the Weibull and lognormal models. Although the mean WTP figures remain implausibly large, they decrease by orders of magnitude when the outliers are excluded. By contrast, median WTP rises, implying that the upper tail of the distribution is thinner after the outliers have been removed.²³ This

²² We remind the reader that Johannesson et al. fit the logit model corresponding to equation (6.1), then compute mean WTP by integrating the area under \hat{p}_i between zero and infinity. This integral has a closed-form expression, which is equal to $(-1/\hat{\beta}) * \ln[1 + \exp(\hat{\alpha})]$.

²³ We also checked what would happen if we changed the distributional assumption about WTP. If we replace the bid amount with log bid, which follows from the assumption that WTP is a loglogistic, there would 3 outliers when the cutoff is 0.20, 29 when it is 0.25,

suggests that the exclusion of outliers defined in this way has an effect similar to the removal of “yea-sayers” (see section 7).

One would expect that when an outlier is defined as an observation with a high predicted probability of a “no,” but an actual “no” observed, would produce the opposite effects of WTP. However, we could not identify many outliers defined in this fashion in the Johannesson et al. data. Only when the cutoff was 0.40, in fact, were we able to find 13 potentially suspect observations.

B. Outliers with Respect to Income

Income is an important independent variable to include included in regressions relating WTP to individual characteristics of the respondent. There are several reasons why researchers regress WTP on household (or personal) income. First, this is a common practice for testing the internal validity of the WTP responses, as theory suggests that WTP for mortality risk reductions should be positively associated with income. Second, there is much interest in the income elasticity of WTP for the purpose of predicting WTP at specified levels of income within the sample, or for benefit transfer purposes.²⁴

Measuring income from surveys of individuals is, however, problematic. If, as it is sometimes suggested, income is a variable observed with a random observation error, and a regression is run that relates WTP on income (plus other variables), one would expect the coefficient on income to be biased towards zero. The income elasticity of WTP would, therefore, be underestimated.²⁵

Measuring income is particularly difficult for certain persons, such as those with income that tends to fluctuate between one year and the next (the self-employed, or workers in highly seasonal industries, like construction) and for the elderly living on retirement and investment incomes, who sometimes fail to include social security among their sources of income. It is not unusual for retired person to report very low incomes, even if their wealth is very large. For this reason, consumer expenditure surveys like the University of Michigan’s Survey of Consumer Finances inquire about social security payments, ownership of land and homes, and money in retirement and savings accounts to get a better sense of the wealth of individuals. Answering the income question is also difficult for college students.

and 29 when the cutoff is 0.30. The effect on mean WTP is qualitatively similar to that shown in table 6.1.

²⁴ It is recognized, however, that knowing the income elasticity of WTP in a cross-sectional sample sense does not answer the important policy question of whether VSL should change over time, as income grows and the tradeoffs people are prepared to make between income and risk reductions change.

²⁵ I would like to thank Trudy Cameron for raising this issue.

Another frequently encountered problem is that many people fail to answer the income question altogether, which results in many missing values. Researchers with extensive experiences in the design and administration of surveys (Richard T. Carson, personal communication) report that income is often the variable that tends to have the highest item non-response rate in a CV surveys. In the Johannesson et al. study, for example, 86 out of 2028 (4.24%) individuals failed to report any information about their personal or household income. In the Alberini et al. US study, 12.78% percent of wave 1 skipped the income question, whereas 2.9% of the Persson sample failed to answer the income question.²⁶

Individuals may also intentionally misrepresent their income. For example, relatively wealthy individuals may deliberately underreport their income, while at the same time announcing a relatively large WTP amount, and other individuals may intentionally overstate their income. These tendencies can sometimes be uncovered by comparing these subjects' education with reported income.

In contingent valuation surveys about environmental quality or other public goods, researchers expect WTP to be a small fraction of the respondent's income. This expectation has led them, in some cases, to exclude from the sample respondents whose implied WTP is greater than, say, 5% of the respondent's income. With reductions in one's own risk of dying, there is no particular reason to believe that WTP *should* be a small proportion of income, but it seems appropriate to check for respondents whose announced WTP is a relatively large proportion of income, and to examine how robust the estimate of mean WTP is to excluding these respondents from the sample. Respondents with very high announced WTP relative to income may have failed to give proper consideration to their budget constraint, may have intentionally misrepresent their income, or may have miscalculated their income.

We use the data from the mortality risk survey conducted in the US by Alberini et al. (forthcoming) to investigate this matter. Results from estimating mean WTP after excluding respondents with implied WTP greater than a given percentage of income are shown in Table 6.3. We vary this percentage from 25 (the least stringent criterion) to 2.5 (the most stringent criterion), showing how doing so excludes from a minimum of 68 to a maximum of 133 respondents (almost one-third of the sample). As in Alberini et al., the WTP estimates in table 6.3 are based on a Weibull interval-data model that combines the responses to the initial WTP questions and to the follow-up questions in a double-bounded fashion. Table 6.3 shows that mean and median WTP do decline as we exclude more observations from the sample, but the change is within 10-12% of the original figures.

²⁶ These percentages are actually reasonable when compared with other CV studies on different topics. For example, we recently participated in the design and administration of a CV survey about coastal erosion and the Lagoon of Venice, which was conducted over the telephone. The item non-response rate for household income was about 31%.

Table 6.3

Outliers with respect to income. Alberini et al. US Survey
WTP for 5 in 1000 risk reduction, wave 1, cleaned sample*

	Exclude if...	N	Mean WTP (\$)	Median WTP (\$)	Income elasticity of WTP
Least stringent	(all sample)	551	752.84 (88.37)	346.21 (28.45)	0.16
	WTP \geq 25% of household income	483	755.56 (90.84)	362.38 (31.97)	0.16
	WTP \geq 10% of household income	477	747.53 (90.02)	355.14 (29.24)	0.29
	WTP \geq 5% of household income	458	719.25 (89.21)	339.33 (30.02)	0.52
Most stringent	WTP \geq 2.5% of household income	418	678.39 (91.64)	302.26 (28.67)	0.92

* Excludes those who failed the probability quiz and the probability choice.

By contrast, what *does* change dramatically is the income elasticity of WTP, a key quantity when one wishes to (i) extrapolate study results to the general population, (ii) focus on the economically disadvantaged, and (iii) attempt benefit transfers to other countries or locales where income levels are different. As shown in table 6.3, income elasticity of WTP is 0.16 when the full sample is used, 0.29 when persons whose implied WTP amount is greater than 10% of household income are excluded, 0.52 when we exclude persons whose WTP is greater than 5% of household income, and, finally, 0.92 when the most stringent criterion is used.

This suggests that predictions for how WTP changes as income changes would vary dramatically, depending on which of these “cleaned” sample, and the corresponding estimates, one opts for.

Further investigation reveals that the 65 respondents who violated the most stringent exclusion criteria were slightly older than the remainder of the sample, but not significantly so (average ages were 57 and 54, t statistic of the null of no difference = 1.38), significantly less educated than the remainder of the sample (11.75 years of schooling v. 13.3, t statistic = 6.27), and reported much lower annual household income than the rest of the sample (sample averages: \$17,942 v. \$56,151, t statistic 22.18).^{27 28}

²⁷ The median annual household income is \$17,500 and \$55,000, respectively.

²⁸ It is possible that these respondents miscalculated or intentionally underreported their income. I regressed log income on age, age squared, education and the gender dummy for the full sample, and used the results of this regression to compute predicted income. For

Moreover, they were twice as likely to indicate, in the debriefing section of the survey, that they had misunderstood the timing of the payment (27% of this group versus 13% of the remainder of the sample, with a t statistic of 4.66).

Next, we turn to the Persson et al. data. One respondent in Persson et al.'s sample reports a WTP amount that is 83% of annual household income. Fortunately, the rest of the sample is more reasonable: Ninety-nine percent of the sample holds a WTP amount for reducing fatal auto accident that is equal to or less than 12.5% of household income. In their analysis, Persson et al. discard from the usable sample observations such that WTP accounts for more than 5% of annual household income. This loses 29 observations.

Table 6.4 displays mean WTP for the full sample, and when persons with relatively high WTP/income ratios are excluded from the usable sample. This table shows that while median WTP remains the same for the various exclusion criteria, mean WTP jumps from 1875 to 2778 SEK when we reinstate into the sample those respondents whose WTP was more than 5% of household income. This is a 50% increase in WTP.

Table 6.4. Persson et al. study. Effect of excluding observations with large annual WTP/household income ratios. All values in 1998 SEK.

Exclusion criterion	Number of observations in the sample	Sample average WTP	Sample Median WTP
None	637	2778	1000
Respondents with zero income but positive WTP	637	2778	1000
WTP greater than 50% of household income (least stringent)	636	2635	1000
WTP greater than 25% of household income	633	2163	1000
WTP greater than 20% of household income	632	2151	1000
WTP greater than 12.5% of household income	631	2143	1000
WTP greater than 10% of household income	629	2134	1000
WTP greater than 5% of household income (most stringent)	618	1875	1000

Table 6.5 displays the income elasticity of WTP when observations where WTP accounts for a relatively large share of household income are omitted from the sample. As explained in detail in section 9, we estimate a system of simultaneous equation for log

the 65 respondents with high WTP/income ratio, income predicted on the grounds of education, gender and age was always larger than reported income.

baseline risk and log WTP. The right-hand side of the WTP equation include the logarithmic transformation of the absolute risk reduction, log miles traveled in a car in a year, a dummy accounting for previous injuries sustained in a car accident, log age, log age squared, two education dummies, and dummies for the size of the household in various age groups. Table 6.5 shows that income elasticity of WTP doubles when we move from the sample created with the least restrictive criterion to the most stringent criterion. It remains, however, relatively low (0.28).

Table 6.5. Persson et al. study. Effect of excluding observations with large WTP/household income ratio on the income elasticity of WTP. 2SLS estimation, dependent variable: log WTP for risk of dying in a road traffic accident.

Exclusion criterion with respect to income	Number of observations	Income elasticity of WTP	Standard error
None	514	0.1475	0.1136
Respondents with zero personal income but positive WTP	514	0.1475	0.1136
WTP greater than 5% of household income	501	0.2850	0.1109
WTP greater than 10% of household income	509	0.2264	0.1139
WTP greater than 12.5% of household income	510	0.1937	0.1129
WTP greater than 20% of household income	511	0.1668	0.1126
WTP greater than 25% of household income	512	0.1418	0.1119
WTP greater than 50% of household income	514	0.1475	0.1136

Observations with missing baseline risk and missing WTP, observations with baseline risk smaller than 1 in 100,000, observations with WTP less than 1. Other regressors in the WTP equation: log degrid, log riskmd, log miles traveled in a car, previously injured in a traffic accident (dummy), log age, log age squared, two education dummies, dummies for household members. Coefficients of log degrid and log riskmd are restricted to be equal.

Conclusions

- Outliers alter WTP and VSL to an extent that depends on the data and on the definition of outlier used. Researchers should inspect their data for outliers and report estimates for the full sample as well as after outliers are excluded.
- There is no unambiguous criterion for considering one's WTP as "large" relative to this person's income. However, researchers should check how the estimates of WTP and other coefficients of interest are affected by including and excluding from the usable sample those respondents whose announced WTP is high relative to income.

- These observations could be the result of inaccurate calculation of income on the part of the respondent, or inattention to other details of the risk reduction scenario, as shown by the example based on the Alberini et al. data.
- To limit the measurement error for income, it might be useful to remind respondents about considering all relevant sources of income when answering to give the income. (Retired persons, for example, could be instructed to include social security and other transfer payments, while students could be instructed on how to regard their own income versus their parents'.)
- It may also be helpful to phrase the income question in a manner consistent with the frequency of wages, paychecks, or work contracts typical of the population being surveyed. For example, Lanoie et al (1995), who were interviewing Canadian workers at their workplace, queried them in terms of income per week. Most US surveys inquire about annual income, and most European surveys inquire about monthly after-tax income.
- Outliers and observations with disproportionate WTP to income ratios may occur because the respondent misunderstands the scenario. This reinforces the concept that it is useful to include debriefing questions at the end of the questionnaire to uncover possible misinterpretation of the scenario on the part of the respondent.

7. UNDESIRABLE RESPONSE EFFECTS: MIXTURES

A. Mixtures with Yea-saying, Nay-saying, and Random Answers

Contingent valuation studies about mortality risk reduction rely crucially on the respondent's comprehensions of the risk and risk reductions being valued. This raises the question whether, in spite of visual aids and practice questions about risks, some respondents remain confused about the commodity being valued, and their answers to the payment questions might be affected by undesirable response effects.

Carson (2000) describes three types of undesirable response effects that may occur in dichotomous choice CV surveys. The first is yea-saying, the phenomenon where a respondent answers "yes" to the bid question with probability 1, regardless of the bid amount. This may be done in an effort to please the interviewer, or in hopes to terminate the interview sooner.

By contrast, nay-saying is said to occur when the respondent answers "no" with probability 1, regardless of the bid amount. Respondents engaging in nay-saying may dislike new public programs and new taxes, or might be afraid to commit to something they do not fully understand.

It is also possible that, when queried about risk reductions, some people give completely random responses, answering "yes" to the payment question with probability 0.5 (and hence, "no" with probability 0.5), regardless of the bid amount. Completely random responses may be due to confusion about the scenario, failure to understand the commodity being valued, no interest in the survey, poorly written survey questions or survey materials, or simply a data entry error.

In practice, not all respondents in a contingent valuation survey will be subject to these undesirable effects. In this section, we therefore consider discrete mixtures to accommodate for this possibility. For simplicity, attention is restricted to discrete mixtures with two components, where a small fraction of the sample (α) is affected by one of these undesirable response effects, while the remainder of the sample answers the payment questions in the usual fashion (i.e., saying "yes" if latent WTP is greater than the bid, and "no" otherwise).²⁹ The econometrician's problem is that—unless respondent

²⁹ The dichotomous choice approach is currently the most widely used format for eliciting information about the respondent's willingness to pay for an improvement in environmental quality or reduction in the risk of death in contingent valuation surveys. In the single-bounded variant of the dichotomous choice approach, respondents were asked one payment question. In recent years, however, researchers have increasingly resorted to the so-called double-bounded approach in hopes of refining information about the respondent's WTP amount. The standard statistical model of the responses to dichotomous choice questions assumes that the respondent's WTP amount is a draw from a specified distribution of WTP (e.g., normal, logistic, Weibull), and that the respondent answers "yes" ("in favor of the plan") if WTP amount is greater than the bid, and "no"

or interviewer debriefs are used—it is not possible to tell which component of the mixture the respondent is drawn from.

In this chapter, we describe statistical models of mixtures of responses to dichotomous choice payment questions in contingent valuation (CV) surveys and apply these models to the data from four CV surveys about individual willingness to pay for reductions in mortality risks.

B. Likelihood Functions

In this section, we describe the contribution to the likelihood function in the presence of discrete mixture and single-bounded WTP data. We assume throughout this section that for observations from the non-degenerate component, latent WTP follows the Weibull distribution. This distribution may, of course, be replaced by any other suitable distribution.

When there is a discrete mixture with random responses, only $(1-\alpha)100\%$ responses out of the n observations available are draws from a Weibull distribution of WTP, while the remaining $\alpha \cdot 100\%$ is comprised of persons whose response reflects the outcome of a coin flip. Unfortunately, we do not know which respondent is which, as is typical with mixtures of populations when the sample separation is unobserved, so that the probability of observing a “yes” response to the payment question is:

$$(7.1) \quad \text{pr}(\text{yes} \mid B) = (1 - \alpha) \cdot (1 - F(B; \theta, \sigma)) + \alpha \cdot 0.5$$

where $F(\cdot)$ is the Weibull cdf with parameters θ and scale σ , and B is the bid amount. The probability of observing a “no” is:

$$(7.2) \quad \text{pr}(\text{no} \mid B) = (1 - \alpha) \cdot (F(B; \theta, \sigma)) + \alpha \cdot 0.5.$$

These expressions can be specialized to the Weibull cdf to obtain:

$$(7.3) \quad \text{pr}(\text{yes} \mid B) = (1 - \alpha) \cdot \exp\left(-\left(\frac{B}{\sigma}\right)^\theta\right) + \alpha \cdot 0.5, \text{ and}$$

$$(7.4) \quad \text{Pr}(\text{no} \mid B) = (1 - \alpha) \cdot \left(1 - \exp\left(-\left(\frac{B}{\sigma}\right)^\theta\right)\right) + \alpha \cdot 0.5$$

otherwise. The associated statistical model is a binary response model (or an interval data model if respondents are asked a follow-up question), and mean and median WTP are computed from the estimated parameters, exploiting the properties of the distribution of WTP (Cameron and James, 1987).

When a sample of well-behaved sample of respondents is “contaminated” with a small percentage, α , of nay-sayers, an observed “no” response could be due to a legitimately low WTP amount, relative to the bid level, or to the fact that the respondent is a nay-sayer. Formally,

$$(7.5) \quad \text{pr}(\text{no} | B) = (1 - \alpha) \cdot (F(B; \theta, \sigma)) + \alpha \cdot 1, \text{ and}$$

$$(7.6) \quad \text{pr}(\text{yes} | B) = (1 - \alpha) \cdot (1 - F(B; \theta, \sigma)).$$

In the case of the Weibull distribution, these contributions to the likelihood are simplified to:

$$(7.7) \quad \text{pr}(\text{no} | B) = (1 - \alpha) \cdot \left[1 - \exp\left(-\left(\frac{B}{\sigma}\right)^\theta\right) \right] + \alpha \cdot 1 \text{ and}$$

$$(7.8) \quad \text{pr}(\text{yes} | B) = (1 - \alpha) \cdot \exp\left(-\left(\frac{B}{\sigma}\right)^\theta\right).$$

Finally, when the contaminating population is a population of yea-sayers, an observed “yes” response could come from a respondent who holds an underlying, positive WTP amount greater than the bid level B , or from a yea-sayer. The probability of observing a “yes” is:

$$(7.9) \quad \text{pr}(\text{yes} | B) = (1 - \alpha) \cdot (1 - F(B; \theta, \sigma)) + \alpha \cdot 1,$$

since a yea-sayer answers “yes” with probability one, regardless of the bid level that has been assigned to him or her. Only persons with genuinely low WTP amounts provide “no” answers:

$$(7.10) \quad \text{pr}(\text{no} | B) = (1 - \alpha) \cdot (F(B; \theta, \sigma)).$$

Again, the final expressions of the contribution to the likelihood in the presence of yea-saying and Weibull distribution of WTP are:

$$(7.11) \quad \text{pr}(\text{yes} | B) = (1 - \alpha) \cdot \exp\left(-\left(\frac{B}{\sigma}\right)^\theta\right) + \alpha \cdot 1, \text{ and}$$

$$(7.12) \quad \text{pr}(\text{no} | B) = (1 - \alpha) \cdot \left[1 - \exp\left(-\left(\frac{B}{\sigma}\right)^\theta\right) \right].$$

D. Application

In this section, we apply the mixture models with completely random responses, yes-saying and nay-saying to the data collected through three CV surveys about mortality risk reductions.

The first study was conducted by Krupnick et al. (2001) in Canada using a self-administered computer instrument. The second study is the US version of the Canada contingent valuation survey, the data being collected using Web-TV from a panel that is supposed to be representative of the US population for age, gender, race and income (Alberini et al., forthcoming). Although each respondent valued three risk reductions that differed for size and timing, in this report attention is restricted to the 5 in 1000 risk reduction from wave (subsample) I and to the “yes” or “no” responses to the initial and follow-up payments questions.

Table 7.1 presents the percentage of “yes” responses to the initial bid amount for the Canada and the US studies. In table 7.2 I present the results of the mixture models for Canada using only the responses to the initial payment questions (single-bounded data). Table 7.3 refers to mixtures where equations (7.1)-(7.11) have been amended to accommodate the responses to the initial payment questions and to the follow-ups (double-bounded data) for Canada. Table 7.4 refers to the US study data, focusing on the single-bounded data because models using the initial and follow-up responses were poorly behaved.

Table 7.1. Percentage of yes responses to the initial payment questions in the Krupnick et al. (2001) and Alberini et al. (2002) studies. Risk reduction of 5 in 1000, wave I.

Bid amount (2000 US dollars)	Percentage Yes Responses	
	Canada study	US Study
70	71.52	68.84
150	66.87	62.50
500	42.14	41.06
725	25.81	34.78

Three caveats are in order. The first is that because α , the probability of the mixing component, should be non-negative and less than one, we programmed my likelihood functions so as to impose that $\alpha = \Phi(\delta)$, where Φ is the cdf of the standard normal, and δ is a parameter to be estimated. However, the optimization routine (GAUSS MAXLIK) often encountered convergence problems, with δ tending to extremely small negative numbers (which implies that $\Phi(\delta)$ tends to zero). To circumvent this problem, we dropped the requirement that $\alpha = \Phi(\delta)$, and switched to the constrained maximum likelihood procedure in GAUSS, forcing the routine to consider only values of α between 0 and 1 ($0 \leq \alpha \leq 1$).

The second is that after estimating the mixing component α , mean and median WTP are computed using the parameters of the well-behaved component of the mixture, i.e., the Weibull distribution. (In other words, the degenerate component is “filtered out” when computing mean and median WTP.) The third is that we produce standard errors based on bootstrapping draws from the asymptotic distribution of the estimated coefficients, but these are very similar to those obtained by than using the delta method (Cameron, 1991).

Table 7.2 shows that if one ignores the possibility of a discrete mixture (first column), and uses only the responses to the initial payment questions, mean WTP from the Canada study is quite large (1177 Canadian dollars for a risk reduction of 5 in 1000 over 10 years). This is, in fact, over twice as large as median WTP (Can \$446). Allowing for the possibility that some people may provide completely random answers (second column) reduces mean WTP to Can \$595, but keeps median WTP relatively close to the previous estimate (Can \$551), as expected (see Figure 2.1). One problem, however, is that the estimate of α is very large, and implies that virtually half of the population would be expected to be answering the payment questions in a completely random fashion. Clearly, this is not plausible, since the answers to the debrief questions suggested that people had paid attention to various aspects of the risk reduction scenario and for the most part accepted it.

The third column of the table suggests that about a quarter of the sample might consist of nay-sayers. Accounting for their presence, and focusing on the distribution of the well-behaved responses to the payment questions, slightly lowers the estimate of mean WTP, and dramatically raises median WTP. The two are now very close (Can \$969 v. 859). The standard errors of the estimates around mean WTP were omitted from the second and the third columns of table 7.3 because they were implausibly large, the results of some very large draws from the asymptotic distribution of the vectors of parameter estimates. Finally, there is no evidence of yea-saying, and α for this model is pegged at zero.

One would expect the mixture models based on double-bounded data to be better behaved. Combining the responses to the initial and follow-up questions refines information about WTP, and should make it easier to detect “bulges” in the frequencies of the responses to the payment questions that suggest possible departure from the conventional model. Indeed, table 7.3 shows that there is no longer any evidence of yea-saying and nay-saying, but the probability of a completely random response continues to be implausibly large. It is, in fact, even larger than when single-bounded models were used. Despite an estimated α of 0.66, neither mean or median WTP are affected. The former is within 5 dollars of the estimate from the traditional model, the latter only 8 cents smaller than its counterpart from the conventional model.

This finding is in sharp contrast with the answers to debriefing questions and the good internal consistency and validity shown by study participants, raising doubts about the ability of single-bounded models of WTP to capture the correct proportion of subjects engaging in degenerate response mechanisms. No evidence of any mixing component is found in the US study, where α is zero for all of the discrete mixtures we examined.

Table 7.2. Estimation results for the Canada mortality risk reduction survey based on single-bounded data. Standard errors in parentheses.

	No mixture	Mixture with completely random responses	Mixture with nay- sayers	Mixture with yea-sayers
θ	0.6159 (0.0681)	1.8785 (1.2810)	1.5975 (0.6040)	0.6159 (0.0681)
σ	808.6715 (90.50)	669.75 (76.06)	1081.29 (81.63)	808.6715 (90.50)
α	--	0.5108 (0.1306)	0.2644 (0.0501)	--
Log L	-391.34	-390.15	-389.34	-391.34
Mean WTP (\$)	1176.94	594.55	969.57	1176.94
Bootstrap Std error around mean WTP	306.55	N/A	N/A	306.55
Median WTP (\$)	445.99	551.04	859.61	445.99
Bootstrap Std error around median WTP	44.02	146.05	134.10	44.02

Table 7.3. Estimation results for the Canada mortality risk reduction survey based on Double-bounded data. Standard errors in parentheses.

	No mixture	Mixture with completely random responses	Mixture with nay sayers	Mixture with yea-sayers
θ	0.6274 (0.0285)	0.1921 (0.0829)	0.6274 (0.0285)	0.6274 (0.0285)
σ	580.77 (35.28)	1123.13 (326.60)	580.77 (35.28)	580.77 (35.28)
α	--	0.6577 (0.0448)	0.00	0.00
Log L	-1077.14	-988.60	-1077.14	-1077.14
Mean WTP (\$)	826.41	831.24	826.41	826.41
Bootstrap Std error around mean WTP	70.85	70.92	70.85	70.85
Median WTP (\$)	323.83	323.75	323.83	323.83
Bootstrap Std error around median WTP	20.96	21.10	20.96	20.96

The third study we use to experiment with mixture models is Johannesson and Johansson (1996). This study was conducted in Sweden, respondents were interviewed over the

telephone and no visual aids were used. Respondents were told that the probability of surviving until age 75 was X , that the average 75-year old survives for 10 more years, and were queried about their willingness to pay for a medical treatment that would increase their expected life expectancy past age 75 by another year. The elicitation approach is a dichotomous choice question with no follow-ups. Table 7.4 shows the percentage of yes responses to the payment question.

Table 7.4. Percentage of “yes” responses to the payment questions in Johannesson and Johansson (1996).

Bid amount (SEK)	Percentage Yes Responses
100	53.22
500	38.58
1000	31.38
5000	22.63
15000	13.64
50000	9.09

Table 7.5 Estimation results for the Johannesson and Johansson 1996 study. Standard errors in parentheses. $N=2013$.

	No mixture	Mixture with random coin flipping	Mixture with nay sayers	Mixture with yea-sayers
θ	0.2118 (0.0145)	0.2539 (0.0537)	0.2118 (0.0145)	0.2118 (0.0145)
σ	673.88 (114.55)	557.96 (133.59)	673.88 (114.55)	673.88 (114.55)
α	--	0.1039 (0.0990)	--	--
Log L	-1079.87	-1079.57	-1079.87	-1079.87
Mean WTP (SEK)	50,574.65	12,110.20	50,574.65	50,574.65
Bootstrap Std error around mean WTP	34,759	N/A	34,759	34,759
Median WTP (SEK)	119.44	132.00	119.44	119.44
Bootstrap Std error around median WTP	30.47	36.73	30.47	30.47

As shown in columns three and four of table 7.4, we do not find any evidence of nay-saying or yea-saying. Column two suggests that about 10 percent of the population might provide completely random responses. This is a much more reasonable figure than in the previous studies. Correcting for this lowers the estimate of mean WTP, which was originally very high (over 50,000 SEK, or about 6000 US dollars), bringing it town to

12,000 SEK. However, chapter 5 suggests that mean WTP cannot be reliably estimated using the data from this study, unless one is prepared to make restrictive assumptions about the distribution of WTP and/or the calculation of the mean. Median WTP, on the other hand, is only minimally affected (132 SEK versus 119 SEK in the traditional model).

Our own research on discrete mixtures with dichotomous-choice CV responses, however, suggests that it is difficult to estimate in the mixing components in a reliable fashion. In Alberini and Carson (2001), Monte Carlo simulation methods suggest that with single-bounded dichotomous choice responses are used, α is often overestimated, despite the fact that for a considerable fraction of the replications α is pegged at zero. Using double-bounded CV responses generally improves the performance of the mixture models, and does a reasonable job identifying α . However, this is so only when the distribution of the non-degenerate component of the mixture is correctly guessed by the researchers. These simulations also suggest that the estimated α frequently captures a poorly chosen distribution for the non-degenerate component of the mixture. Moreover, being able to correctly estimate α depends crucially on assuming the correct mixture (e.g., that there truly is yea-saying, as opposed to another form of “contamination”).

In practice, we suspect that mixtures with different components are likely to coexist in a sample, but identifying them is extremely difficult, unless well-crafted debriefing questions are included in the questionnaire to assist the researcher in uncovering potentially troublesome observations. For example, the NOAA Panel on Contingent Valuation recommend that questions be asked to find out why a respondent answered “yes” or “no” to the (dichotomous-choice) payment questions. In addition, debriefing questions should be asked at the end of the questionnaire to find out if the respondent has understood all aspects of the scenario.

Conclusions.

- Discrete mixtures can be used to accommodate for nay-saying, yea-saying, and completely random responses in dichotomous choice CV surveys.
- It seems likely that the samples from many studies would simultaneously include more than one of these undesirable response effects.
- Experimentation with various datasets, however, suggests that unless the sample separation is known, it is difficult to identify reliably the components of a mixture. This suggests that researchers should include questions about the reasons for the “yes” or “no” responses to the payment questions, and include debriefing questions to make sure if the respondent had understood the good being valued and various aspects of the scenario.
- Median WTP is robust to the presence of individuals who answer the payment questions in a completely random fashion, but is not robust to the presence of yea-saying and nay-saying.

8. INTERPRETATION OF THE WTP RESPONSES: CONTINUOUS AND INTERVAL DATA, AND ZERO WTP

In this section, we focus on issues of interpretation of the responses to the payment questions, which in turn defines their treatment in the statistical model. We begin with the issue of zero WTP responses, followed by the continuous v. interval-data treatment of WTP observations pinpointed by the respondent on a payment card.

As previously mentioned, the questionnaire used by Krupnick et al. (2002) in Canada uses the dichotomous choice approach with one follow-up question. Those respondents who answered “no” to the initial and follow-up question were asked if they would pay anything at all for the product that reduced their risk of dying, and, if so, how much.

In the analysis of the WTP responses for the 5 in 1000 risk reduction from wave 1, Krupnick et al. focus on a “cleaned” sample that had demonstrated basic probability comprehension,³⁰ and report that almost 20 percent of the sample was not willing to pay anything at all for the risk reduction. Their sample, therefore, contains a mix of zero WTP responses, and continuous and interval data. They adapt a tobit model to this mix of response types, obtaining a variant of the so-called “spike” model (Kriström, 1997). Formally,

(8.1)

$$\log L = \sum_{i \in \mathfrak{S}_0} \log[1 - \Phi(-\mu / \sigma)] + \sum_{i \in \mathfrak{S}_C} \log \frac{1}{\sigma} \phi\left(\frac{WTP_i - \mu}{\sigma}\right) + \sum_{i \in \mathfrak{S}_{DB}} \log \left[\Phi\left(\frac{WTP_i^U - \mu}{\sigma}\right) - \Phi\left(\frac{WTP_i^L - \mu}{\sigma}\right) \right]$$

where \mathfrak{S}_0 is the subset of respondents with zero WTP, \mathfrak{S}_C includes all respondents who report continuous WTP amounts (denoted as WTP_i), and \mathfrak{S}_{DB} includes all respondents with YN, NY, and YY responses. WTP_i^U and WTP_i^L are the upper and lower bounds of the interval around the true WTP amounts for these respondents.³¹

Mean WTP is $\int_0^\infty \left[1 - \Phi\left(\frac{x - \mu}{\sigma}\right) \right] dx$. Although this is similar to the formula that was used

by Johannesson and Johansson (1996) and Johannesson et al. (1997), it should be emphasized that the two econometric models, and the WTP responses on which they are

³⁰ Specifically, the cleaned sample excludes those respondents who failed the probability quiz and the probability choice question the first time. The probability quiz asks respondents to tell which of two people, A and B, has a greater chance of dying, if A’s risk is 5 in 1000 and B’s is 10 in 1000. The probability choice question asks respondents to consider the same two people, and to tell which person they would rather be. A total of 611 respondents out of 630 in wave 1 met this selection criterion.

³¹ If a respondent answers YY to the payment questions, then the lower bound of the interval around WTP is the follow-up bid, while the upper bound is infinity.

based, are completely different. In the latter two studies, the researchers did *not* observe any zero WTP responses, but simple “yes” and “no” to a one-shot payment question. There was no reason to assume that WTP should be negative, but the researchers used a distributional assumption that admits negative values, only to later discard the negative range of the distribution of WTP when calculating mean WTP.

With a cleaned sample of 616 observations, 19.64% being zero WTP responses, the spike model produces an estimate of mean WTP equal to 597.72, with a standard error around mean WTP equal to 27.09. The log likelihood function is -1363.47.

In subsequent work, Alberini et al. (forthcoming) ignore the responses to the final round of open-ended questions, and use only the responses to the initial and follow-up payment questions. This produces a double-bounded, interval-data model. Table 8.1 reports mean and median WTP under various distributional assumptions for WTP from double-bounded models. Of the models shown in table 8.1, the Weibull is the best in terms of fit, based on the log likelihood function, with the lognormal a close runner-up.

Table 8.1. Results from double-bounded models for the Canada study, Krupnick et al. (2002). All figures in 1999 Canadian dollars. N=616 (cleaned sample).

	Normal	Lognormal	Weibull
Mean WTP (Standard Error)	556.23 (26.37)	1087.61 (129.10)	712.42 (75.94)
Median WTP (Standard Error)	556.23 (26.27)	367.53 (24.20)	414.42 (25.28)
Log likelihood function	-845.55	-789.75	-788.27

Comparison with the spike model indicates that the estimate of mean WTP produced by the normal double-bounded is not very different from that of the spike normal based on the normal distribution. The Weibull double-bounded model results in a mean WTP figure that is about 1.7 times median WTP, and, as expected, the difference between mean and median WTP is even more pronounced when WTP is assumed to be lognormal. The mean WTP from the lognormal model is almost twice as large as that from the spike model.

Despite Alberini et al.’s decision to ignore the zero WTP responses and ascribe a positive WTP to these respondents, it would seem that those subjects who reported zero WTP in this questionnaire probably meant to do so: after all, they were specifically queried about this in the course of the survey. This suggests that one should consider a third alternative to the spike model and to double-bounded models, namely a mixture with two components where the sample separation is known. Specifically, for $(1-\alpha) \cdot 100\%$ of the sample WTP is identically equal to zero. For the remaining $\alpha \cdot 100\%$ of the sample WTP is assumed to follow the Weibull distribution. Mean WTP is, therefore, $0 \cdot \alpha + (1-\alpha) \cdot \text{MWTP}$, where MWTP is mean WTP for the non-degenerate component of the Weibull. Since a double-bounded model estimates the latter to be Can \$813.21 (s.e.

46.54), mean WTP in the full sample is Can \$653.49 (37.39). Clearly, this figure is between the figure produced by the spike model and that from the procedure that ignores the presence of zero WTP responses.

In the Gerking et al study (1988), the respondents were asked to circle dollar amounts shown on a payment card. Gerking et al. treat these responses as continuous, except for those corresponding to the figure of \$6001 (the largest sum on the payment card) and more. Cameron and Huppert (1988) argue that payment cards imply interval-censored observations, and that a respondent's true WTP amount lies between the figure he circled on the payment card and the next amount. For example, if the respondent has circled \$100 on the payment card on page 4 of the questionnaire, it is assumed that true WTP lies between \$100 and \$120, the next amount on the card. Following this reasoning, if the respondent has circled \$0, then the lower bound of the interval around WTP is zero, while the upper bound of the interval is \$20. We wish to check if this interpretation of the responses would result in large changes in the welfare statistics.

Table 8.2 reports the results of a tobit model analogous to that used by Gerking et al. (and hence treats zero WTP responses as true zeros), and of a Weibull and a lognormal interval-data models following Cameron and Huppert's argument that amounts circled on a payment cards imply interval-censored observations.

Table 8.2 Welfare statistics for WTP data, Gerking et al. study, 1988. N=476.

	Sample moments or order statistics	Double tobit model, most obs. Treated as continuous	Interval data and Weibull distribution	Interval data and lognormal distribution
Mean WTP	678.60 (71.26)	599.02	2330.13 (748.83)	31910.03 (22843)
Median WTP	20 (118.87)		28.60 (7.26)	28.09 (5.83)

As expected, the two interval-data models based on distributions of WTP defined on the positive real axis result in large mean WTP figures, but agree with each other and with the sample median about median WTP. That the estimates of mean WTP from, say, the Weibull model is much larger than that from the tobit model (almost four times as large) is in sharp contrast with the results from the Krupnick et al. study, where mean WTP from the Weibull, double-bounded model was only about 1.3 times mean WTP from the spike/tobit model. This suggests that the spike versus Weibull model disparities are likely to depend on the specific set of data, and are difficult to quantify exactly.

When we tried the mixture of zero WTP and a Weibull distribution, which we estimate assuming that observations are continuous, except for \$6001 and higher, the latter produces an estimate of mean WTP equal to \$1443.14 (s.e. 161.60). Since 47.40% of the sample indicates that they would not pay anything at all for the risk reduction, the mixture model yields $(1-0.4790) \cdot 1443.14 = 751.73$, with a standard error of 84.18.

Conclusions

- If the CV questionnaire elicits WTP using the payment card method, the responses should be treated as interval data (Cameron and Huppert, 1988).
- Follow-up questions should be included to find out if a respondent who answers “no” to the dichotomous choice payment questions or circles the number zero on a payment card truly means that he is not willing to pay anything for the risk reduction.
- In the presence of zero WTP responses, (the interval-data variant of) tobit models and mixtures with sample separation known are reasonable alternatives for handling the data.

9. SENSITIVITY OF WTP TO RISKS: ENDOGENEITY OF WTP AND SUBJECTIVE RISKS

Economic theory suggests that willingness to pay for a mortality risk reduction should increase with the size of the risk reduction. Moreover, under general assumptions, WTP should be strictly proportional to the size of the risk reduction (Hammitt and Graham, 1999). Although these requirements seem straightforward, a recent survey of the literature (Hammitt and Graham, 1999) finds that out of 25 empirical stated-preference studies conducted over the previous twenty years, (i) the majority fails to detect a statistically significant relationship between WTP and the size of the risk reduction, whether internal or external scope tests are used, and that (ii) proportionality is often violated.^{32, 33}

WTP is also expected to increase with baseline risks, although when the risks are very small the effect of baseline risk is probably negligible (Hammitt and Graham, 1999). Another important question is whether people respond to the absolute or relative risk reductions (Baron, 1997).

Clearly, checking these effects and answering the question about proportional or absolute risk reduction require that, when the size of the risks are varied to the respondents, regressions be run that relate WTP to risks and risk changes. In some surveys, the researchers ask the respondents to assess their own baseline risks and/or the risk reductions that would be obtained through certain behaviors or by using certain products (Johannesson et al., 1991; Persson et al., 2001). These regressions must, therefore, check for the possible endogeneity of subjective risks and WTP. Such endogeneity arises when both WTP and risks share common unobservable individual factors, and, if left

³² An internal test implies that the same respondent is asked to value risk reductions of different size. An external test implies that different respondents are asked to value risk reductions of the same size. Since the answers to earlier valuation questions may provide implicit cues to the respondent about the value to place on later risk reductions, it is generally felt that external scope tests are more demanding, and hence a CV study would be judged as of higher quality if the researchers can demonstrate that WTP satisfies the external scope requirement. Carson (2000), in commenting on the guidelines set by the NOAA Panel on Contingent Valuation, points out that with most environmental commodities there is no special need to demonstrate the WTP is sensitive to scope, but considers mortality risk reductions an exception to this claim due to the cognitive difficulty associated with small probabilities. Hammitt and Graham (1999) use the term “weak scope” to refer to the requirement that WTP increase with the size of the risk reduction, reserving the expression “strong scope” for the requirement that WTP be proportional with the size of the risk reduction.

³³ Hammitt and Graham (1999) discuss a number of possible reasons why WTP fails to increase with the sizes of the risk reduction, and/or violates proportionality. One obvious reason is that people do not comprehend probabilities. Corso et al. (2001) check which types of visual aids can help people process probabilities, with the end result that WTP satisfies the weak and strong scope effects.

unaccounted for, may result in invalid inference about scope and/or absolute v. relative risk reductions.³⁴

In this section we demonstrate tests of endogeneity of WTP with baseline risks and absolute risks, respectively, using the data from the Gerking et al. (1988) study and the Persson et al. (2001).

A. Endogeneity of Subjective Risks in the Gerking et al study

In the Gerking et al study, respondents were asked to report their subjectively assessed baseline risks, on the grounds that WTP for a reduction in workplace-related risks should depend on perceived risks. The risk ladder used for this exercise expressed risks as X per 4000 workers, and the risk reduction to be valued was, for all respondents, 1 in 4000 from the baseline risks. The purpose of this section is to examine whether baseline risks, when small, truly do not influence WTP for a mortality risk reduction, as argued by Hammitt and Graham (1999). Because the risk reduction did not vary across respondents, it is not possible to test for sensitivity of WTP to the size of the risk change.

This implies that a possible model of WTP is described by the following equation:

$$(9.1) \quad \log WTP_i = \mathbf{x}_i \beta + B_i \delta + \varepsilon_i,$$

where \mathbf{x} is a vector of individual characteristics thought to influence WTP, B is the respondent's subjective annual workplace risk, β and δ are unknown coefficients. The error ε is assumed to be normally distributed.

In equation (9.1), we refer to $\log WTP$, where WTP is the respondent's latent willingness to pay, because I treat the responses to the payment question as interval data for WTP, following Cameron and Huppert (1988). To illustrate, if the respondent has circled \$100 on the payment card on page 4 of the questionnaire, it is assumed that true WTP lies between \$100 and \$120, the next amount on the card. If the respondent has circled \$0, then the lower bound of the interval around WTP is zero, while the upper bound of the

³⁴ The coefficient on the risks in the WTP regression is biased downward if the correlation between subjective risks and WTP is positive. However, the same result would hold if the respondents are *asked* to value objective risk reductions, but replace them with *different* risk reductions of their own invention because they do not believe the effectiveness of a proposed product or policy, or because they did not accept the baseline risks as their own ("I am a better driver than the average"). If the researcher regressed WTP on the objective risks, the latter would be interpreted as a variable observed with an error, and the results of error-in-variables regressions would apply. This relates to one of Hammitt and Graham's possible reasons for the failure of WTP to increase with risk: that the risk valued by the respondents are *not* the risks stated to them in the survey by the researcher.

interval is \$20. Baseline risks B are interpreted as a continuous variable. Testing if baseline risk matters requires testing if $\delta=0$.

B and $\log WTP$ are endogenous if B is correlated with the error term in equation (9.1). This may be the case if both B and WTP are influenced by idiosyncratic, individual-specific factors that remain unobserved to the researcher. If so, any estimation technique that treats the right-hand side variables of (9.1) as exogenous (e.g., OLS or tobit) will give biased and inconsistent estimates.

To remedy this problem, we specify an auxiliary equation where B is explained as a linear combination of instruments \mathbf{z} , plus an error term. Formally,

$$(9.2) \quad B_i = \mathbf{z}_i \gamma + \eta_i.$$

We assume that the error term in (9.2), η_i , is normally distributed. If WTP and B are endogenous, the covariance between ε and η is different from zero, and the two error terms are jointly normally distributed:

$$(9.3) \quad \begin{bmatrix} \varepsilon_i \\ \eta_i \end{bmatrix} \sim \text{i.i.d. } N \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{bmatrix} \right).$$

The distributional assumption in (3) implies that, conditional on subjective baseline risks, $\log WTP$ is equal to $\mathbf{x}_i \beta + B_i \delta + \eta_i \lambda + e_i$, where

$$(9.4) \quad \eta_i = B_i - \mathbf{z}_i \gamma,$$

i.e., the error term in the equation for baseline risk,

$$(9.5) \quad \lambda = \sigma_{12} / \sigma_2^2,$$

and the error term e is a normal with mean zero and variance v^2 equal to $\sigma_1^2 - \sigma_{12}^2 / \sigma_2^2$.

The joint distribution of the WTP responses and baseline risk can, therefore, be expressed as the product of the marginal for baseline risk (which is a normal), times the above described conditional distribution, which is also a normal. If the lower and upper bounds of the interval around a respondent's true WTP amount are denoted as WTP_i^L and WTP_i^H , the respondent's contribution to the likelihood function is:

$$(9.6) \quad \ell_i = \frac{1}{\sigma_2} \phi \left(\frac{B_i - \mathbf{z}_i \gamma}{\sigma_2} \right) \times \left[\Phi \left(\frac{WTP_i^H - m_i}{v} \right) - \Phi \left(\frac{WTP_i^L - m_i}{v} \right) \right],$$

where $m_i = \mathbf{x}_i\beta + B_i\delta + \eta_i\lambda$. Endogeneity can be tested by testing whether the covariance, σ_{12} , is equal to zero, or λ is equal to zero.

Table 9.1 below reports the results of one maximum likelihood estimation run based on equation (9.6). For identification purposes, at least one excluded exogenous variable in the vector \mathbf{z} is not included in \mathbf{x} . The vector \mathbf{z} , the instruments for subjective baseline risks, includes (i) objective baseline risk based on industry and occupation, (ii) the union status of the respondent, (iii) dummies for whether the respondent works in the manufacturing sector and has a blue collar occupation, and (iv) education. Experience was also attempted, but the model failed to converge, and so the specification in table 9.1 omits this variable.

The \mathbf{x} regressors include income, age dummies, gender, education, race, ethnicity, and residence in urban or suburban area. Objective risk, therefore, is the variable that is excluded from \mathbf{x} and included in \mathbf{z} for identification. Regarding other variables, \mathbf{x} includes income, but income is not included in \mathbf{z} . Education is common to both \mathbf{x} and \mathbf{z} .

Table 9.1, top panel, shows that subjective risk is well predicted by objective risk (ORISK), but that the former is not an unbiased estimate of the other: the intercept (CONST) is different from zero, and the coefficient on objective risk implies that a change of one in the objective risk does not translate into a change of one in the subjective risk. (It should be kept in mind that the scale of objective and subjective risks is very different. This study is affected by a large discrepancy between the risks the respondents are asked to look at, and pick his or her own subjective risk out of, which are, on average, 7.4×10^{-4} for this sample, and objective risks, which are only 7.5×10^{-5} . Subjective and objective risks, therefore, differ by an order of magnitude. Both objective and subjective risks were rescaled through multiplying them by 1000 in the regression run shown in table 9.1. The change in the scale of the objective and subjective risks is absorbed into the regression coefficient on objective risks.)

Union members (UNION) and persons with blue collar occupations (BLUE) tend to report higher subjective risks than the others, and the effect of education (EDUC, measured in years of schooling) is insignificant, as is the effect of working in the manufacturing sector (MFG dummy).

WTP for the risk reduction increases with income (significant at the 10% level), and is higher among blacks and lower among persons of age between 40 and 50 years. The coefficients of the other variables were not statistically significant.

Importantly, the correlation coefficient between the errors of two equations, ρ , is insignificant, implying that baseline risk can be treated as exogenous in the WTP equation. Indeed, δ itself is insignificant, implying that baseline risks do not affect WTP: in other words, the amount of money that respondents were prepared to sacrifice to improve by one step on the risk ladder does *not* depend on which particular step of the ladder they start from. This provides support for Hammitt and Graham's claim (1999).

To check if these results are sensitive to the use of a semi-log model of WTP, and my interpretation of the responses to the payment questions (which follows Cameron and Huppert, 1988), I experimented with alternative models that specified a linear model for WTP and interpreted the data to be on a continuous scale. I estimated this model both by two-stage least squares and double-tobit (as in Gerking et al.). While this approach was able to identify more significant determinants of subjective risks (e.g., certain manufacturing sectors), they confirm that baseline risk is not significantly associated with WTP, and that there is no evidence of endogeneity between WTP and baseline risks.

Table 9.1 Continuous/interval-data model with endogenous baseline risk.

bivariate model					
Data Set: data1					

return code = 0					
normal convergence					
Log-likelihood -1046.11					
Number of cases 344					
Covariance matrix of the parameters computed by the following method:					
Inverse of computed Hessian					
Parameters	Estimates	Std. err.	t stat.	P Value	Gradient

RISK EQUATION					
R_CONST	0.8000**	0.1719	4.653	0.0000	0.0000
R_ORISK	0.8772**	0.2420	3.625	0.0003	0.0000
R_UNION	0.1379*	0.0585	2.359	0.0183	0.0000
R_MFG	-0.0642	0.0598	-1.073	0.2834	0.0000
R_BLUE	0.2358**	0.0621	3.794	0.0001	0.0000
R_EDUC	-0.0109	0.0106	-1.031	0.3024	0.0000

WTP EQUATION					
W_CONST	2.9664	1.9644	1.510	0.1310	-0.0001
W_INC	0.0247^	0.0148	1.675	0.0940	0.0000
W_BLACK	2.4058*	1.0232	2.351	0.0187	0.0000
W_HISP	0.7774	1.2830	0.606	0.5446	0.0000
W_EDUC	0.0493	0.0857	0.576	0.5647	0.0000
W_MALE	-0.2827	0.5934	-0.476	0.6338	0.0001
W_AGELES	-0.8910	0.7611	-1.171	0.2417	0.0000
W_AGE404	-1.9771*	0.8557	-2.311	0.0209	0.0000
W_AGE505	-0.8781	0.8364	-1.050	0.2938	0.0000
W_SUBURB	0.5866	0.5901	0.994	0.3202	0.0001
W_RURAL	0.9024	0.6761	1.335	0.1820	0.0000
SIGMA1	0.4708**	0.0180	26.228	0.0000	0.0000
SIGMA2	3.3999**	0.2076	16.373	0.0000	0.0000
RHO	0.0886	0.1728	0.513	0.6082	0.0000
DELTA	-0.3158	1.2020	-0.263	0.7927	0.0001

^ = significant at the 10% level; * = significant at the 5% level; ** = significant at the 1% level.

B. The Persson et al. Survey.

The purpose of examining the Persson et al. data in this chapter is two-fold. First, we wish to explore the importance of allowing for subjective risk reductions to be endogenously determined with the willingness to pay for them. Second, we wish to examine whether respondents were valuing the absolute risk reduction, or simply responding to the proportional risk reduction stated to them in the survey, when answering the WTP questions. Regarding the latter goal, it is of interest to see if the results depend on whether risks are treated as exogenous or endogenous with WTP.

Persson et al. (2001) conducted a mail survey about WTP for mortality risk reduction among adult Swedes in March 1998.³⁵ There were two versions of the questionnaire. The first version of the questionnaire concerns risks of dying in road traffic accidents, while the other focuses on risks of injuries in the same context. In the *Journal of Risk and Uncertainty* article, and in this report, attention is restricted to the former subsample.

The questionnaire can be roughly divided into six sections. The first section queried them about the use of private safety devices such as seatbelts for backseat passengers and helmets, and subsequently elicited extensive information about the distance traveled in a car, by public transit, bicycle, motorcycle, moped and as a pedestrian. At the end of this section, the respondents were asked whether they had ever been injured in an accident, if this had happened the year before, and if anyone else in their household had ever been injured in an accident.

In the second section of the questionnaire, respondents were asked to rate their health on a scale from 0 to 100, where 0 represents the “worst imaginable condition” and 100 represents the “best imaginable condition,” on a thermometer with readings ranging from 0 to 100.

The third section of the questionnaire introduced individual mortality risks. Respondents were told that a fifty-year old³⁶ had a risk of dying of 300 in 100,000 in a year, and were shown on this risk on a grid of squares, which also showed how the risk of dying for certain causes compares to the total risk of dying. Specifically, the questionnaire stated

³⁵ The population targeted by the study was a random sample of Swedes of ages 18-74. The first mailing of the questionnaire was in March 1998, and was followed by two follow-up remainders in hopes of raising the return rate. The overall return rate is 51%. In addition, to check for possible selection into the sample, the authors sent out 2645 “drop out” questionnaires, 659 of which were eventually filled out and returned. The authors conclude that the final sample is wealthier, drives more miles, and has a higher educational attainment than the average Swede and the typical dropout respondent, but does not differ from the Swedish population and dropout respondents in terms of gender and access to a car.

³⁶ This person’s gender was not specified in the questionnaire.

that the risk of dying of heart disease is 54 in 100,000, the risk of dying of cancer in the stomach or esophagus is 6 in 100,000, and the risk of dying in a traffic accident is 5 in 100,000.

After this example, respondents were asked to report their subjective risk of dying in one year, considering their age and current state of health, per 100,000. They were then asked to state how much they would be willing to pay for a reduction in this risk of dying.³⁷ The reduction was expressed in proportional terms, with respondents randomly assigned one of three possible percentages: 10%, 30%, and 50%.

People were asked to refer to safety equipment and preventative health care, and were instructed to think only of the risk of dying (without considering the risk of being injured or permanently disabled). They were also reminded that the risk reduction would apply for one year only, and that they should keep their budget in mind when answering this question.

Following the WTP question, respondents were asked which other category of expenditure (or savings) they would reduce in order to pay for the risk reduction.

In the fourth section of the questionnaire, people were to focus on their risk of dying in a road traffic accident. They were first asked to indicate their own subjective risk of dying in a road traffic accident, after being reminded that they should consider how much they travel, their age and gender, and their own driving behavior when answering this question. Next, they were to consider a safety device that could be worn without any inconvenience or pain, that would reduce risks. The safety device would serve the only purpose of reducing risk, and would have to be paid for every year, offering protection only for that year. Given that the safety device would reduce the risk by a certain percentage, how much would the respondent be willing to pay for it?³⁸

In the fifth section of the survey, the subjects were asked how they would spend an increase of 1000 SEK monthly in their take-home pay. They were shown several categories of expenditure, including food, additional savings, safety equipment and preventative health care. Finally, the respondents were asked the usual socio-

³⁷ The payment question was open-ended, and the WTP responses are on continuous scale. This allows the use of linear regression models and of OLS and 2SLS estimation techniques, but it should be kept in mind that open-ended questions is not regarded as an incentive compatible technique for eliciting information about WTP. If this survey had used dichotomous choice payment questions, it may well have resulted in different WTP estimates.

³⁸ The percentage risk reduction was the same as that in the question about the risk of dying for any cause. However, those respondents who were previously asked about a 30% reduction in the risk of dying for any cause were randomly assigned to one of two possible risk reductions in their risk of dying in a road-traffic accident, 30% and 99%, respectively.

demographic questions and some additional questions about the vehicles in their households, including their safety features.

C. The Persson et al. data

Person et al (2001) focus on the reductions in the risk of dying in road traffic accidents. The dataset that I received from these authors contains a total of 2884 observations. A total of 1384 people answered the question about their own risk of dying for any cause, and 776 of these people also reported a WTP amount for reducing their risks of dying of any cause. Of these 776 people, 32 reported a positive WTP even though their baseline risk, and hence the absolute risk reduction, was zero. (In addition, forty-three people reported WTP amounts despite not answering the question about their baseline risks.)

A total of 1358 people in the dataset answered the question about their own risk of dying in a road transportation accident, and 960 of these people reported a WTP amount for reducing this risk. Twelve respondents estimated their chance of dying in car accident to be zero, implying that no reduction in such a risk was possible, and yet reported a positive WTP amount.

Tables 9.2 and 9.3 report information about the distributions of the subjectively reported risks of dying for all causes and in road-traffic accidents, respectively.

Table 9.2. Variable AEGRISK: subjective risk of dying for any cause.

N	Mean	Std. Dev.	Minimum	Maximum
1384	551.55	5589.39	0	99999

Seventy-three respondents (or 5.27% of the usable data) believed that their own risk of dying is zero. At the other end of the spectrum, two people thought that their risk of dying of any cause in the coming year is 0.50, one person thought his risk was 0.80, another thought it was 0.95, and, finally, two people wrote that their own chance of dying in the coming year is 99.99%. (The latter two respondents rated their health as 95 and 98 on a scale from 0 to 100, suggesting that they are *not* terminally ill.) The median risk was 10 in 100,000.

Regarding the risk of dying in a road accident, only 2.28 percent of the respondents wrote that their risk was zero. The median risk is 3 in 100,000, but the average is 88, which is about an order of magnitude larger than the mean risk in the Swedish population (6 in 100,000). This large average reflects a small number of observations with very high self-assessed risks. For example, two respondents estimate their own risk of dying in a road-traffic accident in the coming year as 50,000 in 100,000.

Table 9.3. Variable DEGRISK: subjective risk of dying in a road-traffic accident.

N	Mean	Std. Dev.	Minimum	Maximum
1384	88.35	1919.09	0	50000

Descriptive statistics about the distribution of WTP for reductions in the risk from all causes and road-traffic fatalities are reported in table 9.4 and 9.5. These tables refer to usable samples that exclude those respondents who estimated their own risks—and hence risk reductions—at zero, and yet reported positive willingness to pay. Observations with missing baseline risks are also excluded.

Table 9.4. WTP for a reduction in the risk of dying for all causes (SEK).

N	Mean	Std. Dev.	Minimum	Maximum
735	2913.46	10822.92	0	150000

Table 9.5. WTP for a reduction in the risk of dying in a road-traffic accident (SEK).

N	Mean	Std. Dev.	Minimum	Maximum
940	2192.95	7255.47	0	100000

Table 9.6.

Frequencies of zero and positive WTP responses.
Usable samples with positive baseline risks and non-missing WTP.

	WTP for any cause		WTP for road traffic accidents	
Percentage risk reduction	Positive WTP	Zero WTP	Positive WTP	Zero WTP
10 percent	92	18 (16.36%)	90	20 (18.18%)
30 percent	443	92 (17.19%)	561	91 (13.95%)
50 percent	70	20 (22.22%)	153	25 (14.04%)
All	605	130 (17.69%)	804	136 (14.47%)

In table 9.6, we report the frequencies of zero and positive WTP. The sample used to compute these frequencies exclude observations with zero baseline risks. This table shows that the percentages of observations with zero WTP ranges between about 14% and 22%, and is on average 17.7% for the question about reducing all risks,³⁹ and 14.5% for the question about traffic risks.

³⁹ It is interesting to note that, at least for the risks of dying for all causes, the percentage of respondents who report zero WTP values does not decrease with the proportional risk reduction, as one would expect.

D. Determinants of WTP and Hypotheses

In this section, we present a model that relates WTP to the absolute risk reduction, so that a VSL can be calculated, while allowing the risk reduction to be endogenous with WTP. For simplicity and to facilitate comparisons with the original Persson et al work, we follow the Persson et al. protocols for constructing the dependent variable and the sample.

We begin by restricting the analysis to WTP in the traffic accident context. It makes sense to report a WTP amount only if the subjective baseline risk, and hence the absolute risk reduction, is positive. Accordingly, following Persson et al., we only include observations for which the subjective risks were greater than 1 (in 100,000). In addition, as in Persson et al., we exclude from the sample those respondents whose WTP for one year is greater than 5% of household income.

Regarding the treatment of zero WTP, Persson et al. estimate three models. The model of table 1 in their article simply drops observations with zero WTP, considers only observations with WTP greater than 1, and takes their logarithmic transformation. The model of table 2 follows the same criteria for constructing the sample and uses log WTP, but replaces the zeros with WTP=2. The model of Table 3 of the Persson et al paper uses the same sample as table 2, but does not take the logarithmic transformation.

In addition, Person et al exclude from the sample those respondents whose subjective baseline risk was so large that the absolute risk reduction ($DEGRISK * RISKMD$) is greater than 10 in 100,000.⁴⁰ We report regression results based on two alternative treatments of observations with large baseline risks and risk reductions. In tables 9.7, 9.8, and 9.9, we exclude observations with baseline risks less than one, but include all others, whereas in table 9.10 we follow Persson et al and exclude observations with absolute risk reduction greater than 10 in 100,000. Comparison between 9.7-9.9 and 9.10 provides evidence about the effect of trimming observations with large subjective risks from the sample.

In formulating our model of WTP, we reason that WTP should be increasing in baseline risk. However, Hammitt and Graham (1999) argue that for small risks the effect of baseline risk on WTP is negligible, and the analysis of the Gerking et al. data confirms that WTP does not depend systematically on baseline risks. We therefore focus on the relationship between WTP and absolute risk, which allows one to calculate VSL.

We assume the WTP equation is:

⁴⁰ They reasoned that greater absolute risk reductions would be not comparable with the risk in the Swedish population, which is 6 in 100,000. After the sample is purged of observations with absolute risk reduction greater than 10 in 100,000, the sample average of subjective baseline risk is 11 in 100,000, which is almost twice as large as the actual risk. Median subjective risk in this cleaned sample is 3 in 100,000.

$$(9.7) \quad WTP = \exp(\mathbf{x}_i \beta_1) \cdot ABSRISK_i^{\beta_2} \cdot \exp(\varepsilon_i),$$

where \mathbf{x} is a $1 \times k$ vector of factors thought to influence risks, $ABSRISK$ is the absolute risk change, and ε is an error term. On taking logs, we obtain:

$$(9.8) \quad \log WTP = \mathbf{x}_i \beta_1 + \beta_2 \log ABSRISK_i + \varepsilon_i.$$

Since $ABSRISK$, the absolute risk, is the subjective baseline multiplied by the proportional risk reduction stated to the respondent in the survey, equation (9.8) can be re-written as:

$$(9.9) \quad \log WTP = \mathbf{x}_i \beta_1 + \beta_2 \log DEGRISK_i + \beta_3 \log RISKMD_i + \varepsilon_i,$$

where $DEGRISK$ is the subjective risk of dying in a road-traffic accident, and $RISKMD$ is the percentage risk reduction assigned to the respondent in the survey. While the latter is exogenously given to the respondent, $\log DEGRISK$ and $\log WTP$ may potentially share common, unobservable characteristics of the respondents. If so, then $\log DEGRISK$ and $\log WTP$ are potentially endogenous. If so, running OLS on equation (9.9) results in inconsistent estimates of the coefficients. This problem may be addressed by using instrumental variable estimation techniques, such two-stage least squares (2SLS).

In writing equation (9.9), we have allowed the coefficients of $\log DEGRISK$ and that of $\log RISKMD$ to be potentially different. We wish to test the null hypothesis that $\beta_2 = \beta_3$, which corresponds to the notion that subjects are thinking of their absolute risk reduction when announcing their WTP estimates. Should this null be rejected, we wish to test whether $\beta_2 = 0$.

If we do not reject the null that $\beta_2 = 0$, but β_3 is found to be different from zero, we would surmise that people in the Persson et al survey were responding to the proportional risk reduction, rather than valuing the absolute risk reduction. This finding would be problematic, in the sense that it is not immediately clear how the VSL can be computed from this study, where everyone is valuing a risk reduction of a different size.

If β_2 and β_3 were different from one another, but each of them was individually different from zero, we would regard this as evidence that individuals give at least some consideration to baseline risks when they announce their WTP amounts.

E. Endogeneity of risks and WTP

To examine if $\log DEGRISK$ is endogenous with $\log WTP$, we specify an additional equation, and instruments, for $\log DEGRISK$. Specifically, we posit that:

$$(9.10) \quad \log DEGRISK = \mathbf{z}_i \gamma_1 + \mathbf{w}_i \gamma_2 + \eta_i,$$

where \mathbf{z} is a vector of instruments, some of which may overlap with \mathbf{x} in equation (9.9), \mathbf{w} is a vector of instruments that are excluded from the right-hand side of equation (9.9) to ensure identification, γ_1 and γ_2 are vectors of coefficients, and η_i is an error term. We allow the covariance between ε and η to potentially differ from zero, in which case log DEGRISK and log WTP are econometrically endogenous.

To test for endogeneity, we estimate (9.10) by OLS, form the OLS residuals, and add the latter to the right-hand side of (9.9). The test of endogeneity is the t statistics on the coefficient of the residuals in this augmented regression (Rivers and Vuong, 1988).⁴¹

If this procedure rejects the null that the coefficient of the residuals is zero, suggesting that there is endogeneity between log WTP and log DEGRISK, we re-estimate the system (9.9)-(9.10) using 2SLS.

F. Results

Table 9.7 reports regression results based on a sample that applies the same exclusion criteria as Persson et al., except that observations with absolute risk greater than 10 in 100,000 are retained. The dependent variable, as in table 1 of Persson et al., is log WTP. Observations with WTP equal to zero are, therefore, dropped.

Column (A) reports the results of OLS regressions that uses the same specification as in table 1 of the Persson et al. paper. (In practice, this can be interpreted as a reduced form regression, where log WTP depends on determinants of subjective risk, such as miles driven, the relative risk reduction, plus income and past experience with accidents, which can influence the rate at which people are prepared to trade off income for risk reductions. However, Persson et al do not necessarily interpret it as a reduced form equation: They simply state that they arrive at this specification through stepwise selection, without explaining whether the selection relies on the judgement of the researcher or on automatic procedures.)

In column (B), we include log ABSRISK, which is the same as including log DEGRISK and log RISKMD, and restricting the coefficients of these two variables to be equal to one another. The estimated coefficient of log ABSRISK is 0.08, implying that WTP grows less than proportionately to the size of the risk reduction. The associated t statistic is only 1.84, implying significance at the 10% level, and suggesting only weak evidence of a scope effect.

In column (C), we report the results of 2SLS estimation. Imposing that log DEGRISK and log RISKMD have the same coefficient, but treating log DEGRISK as endogenous with WTP, results in a coefficient that is almost three times as large. The t statistic, 1.96, indicates marginal significance at the 5% level, suggesting that when subjective risk was

⁴¹ Implicit in this procedure is the assumption that ε and η are jointly normally distributed.

treated as exogenous, its effect on WTP was understated considerably. WTP continues to increase in a less than proportional fashion with risk, however.

We report the results of a regression of log DEGRISK on several instruments in table 9.8 because they are of independent interest and because this is the first stage of the 2SLS procedure. Table 9.8 shows that individuals were able to relate their own subjective risks to exposure (the number of kilometers traveled in a car per year), and to age, but the coefficients of all of the other instruments included in this equation proved insignificant. For example, traveling by moped, motorcycle, or bicycle, which may be presumed to imply higher risks in the event of an accident, was not significantly associated with subjective risks. (In regressions not reported, we tried accounting for the distance traveled by these modes of transportation, but to no avail.) Likewise, using safety equipment was not significantly associated with subjective risks, nor were gender and education level.

Table 9.7. Dependent variable: ldwp (=log WTP). T statistics in parentheses.

	A OLS n=587	B OLS N=587	C 2SLS n=505	D OLS N=587	E 2SLS n=505
Intercept	1.6280 (1.44)	0.3125 (0.23)	-0.1579 (-0.11)	0.7403 (0.54)	-1.7928 (-0.75)
Log income per household member	0.2221** (2.51)	0.2405** (2.43)	0.2994** (2.72)	0.2231* (2.25)	0.3449* (2.08)
Log km traveled in car	0.3855** (4.44)	0.3041** (3.16)	0.2359** (2.42)	0.3318** (3.64)	-0.0957 (-0.39)
Log DEGRISK		0.0847^ (1.84)	0.2077* (1.96)	0.0337 (0.64)	1.5369^ (1.86)
Log RISKMD	0.2569** (2.79)	0.0847^ (1.84)	0.2077* (1.96)	0.2489** (2.61)	0.1390 (0.92)
Injured in accident (Dummy)	0.1563 (1.16)	0.1484 (1.08)		0.1434 (1.05)	0.2519 (1.16)
Log age		0.2009 (1.15)	0.2266 (1.18)	0.1663 (0.95)	0.5887^ (1.64)
Log age squared		0.0202 (0.67)	0.0173 (0.52)	0.0140 (0.46)	-0.0281 (-0.49)
High school diploma		0.1930 (1.21)	0.2136 (1.21)	0.2177 (1.37)	0.1440 (0.54)
College degree		0.2499 (1.54)	0.2293 (1.28)	0.2590 (1.60)	0.2926 (1.09)
Household members ages 0-3		0.0025 (0.02)	-0.0208 (-0.15)	-0.0128 (-0.10)	0.0282 (0.14)
Household members ages 4-10		0.1283 (1.49)	0.1740 (1.93)	0.1298 (1.51)	0.2097 (1.55)
Household members ages 11-17		-0.0887 (-0.89)	-0.0346 (-0.32)	-0.0763 (-0.77)	-0.0256 (-0.16)
Household members ages 18+		0.1637* (2.21)	0.1975** (2.48)	0.1583* (2.14)	0.2015^ (1.71)
Test that b2=b3		F=3.87 Pval = 0.0496			F=2.75 P val=0.0981

Observations with missing baseline risk and missing WTP, observations with baseline risk smaller than 1, observations with WTP less than 1 and with WTP greater than 5% of annual income are excluded.

^ = significant at the 10% level; * = significant at the 5% level; ** = significant at the 1% level.

Table 9.8. First-stage regression. Dependent variable: log DEGRISK. N=518.

	Coefficient	T statistic
Intercept	1.1095^	1.85
Age	-0.0647**	-3.44
Age squared	0.00068**	3.16
Male (CHECK)	-0.0613	-0.69
Log km traveled in a car	0.2816**	3.83
Travels by moped or motorcycle (dummy)	0.0077	0.06
Travels by bicycle (dummy)	0.0735	0.42
Wears helmet when bicycling (dummy)	0.1875	1.36
Uses seatbelt when in back seat of car (dummy)	-0.1374	-1.28
High school diploma (dummy)	0.0489	0.39
College degree (dummy)	-0.0578	-0.46

^ = significant at the 10% level; ** = significant at the 1% level.

In columns (D) and (E) of table 9.7, I re-estimate equation (9.9) by OLS and 2SLS after relaxing the restriction that log DEGRISK and log RISKMD have identical coefficient, and perform tests of the null that $\beta_2 = \beta_3$. The results are rather surprising. When log DEGRISK is treated as exogenous, we marginally reject the null that these two coefficients are equal at the 5% level, but conclude that log DEGRISK is not a significant determinant of log WTP. People, it would seem, responded to the proportional risk reduction, but not to the absolute risk reduction, which does not permit one to compute the VSL.

By contrast, when we use an instrumental variable technique, 2SLS, to allow for log DEGRISK to be simultaneously determined with log WTP, we cannot reject the null that $\beta_2 = \beta_3$ at the 5% level.⁴² When we allow these two coefficients to be different, the subjective baseline is significantly associated with WTP, but the proportional risk reduction is not, which would prompt us to the opposite conclusion about what drives willingness to pay. The coefficients of specification (E), however, are rather different

⁴² It should be kept in mind, however, that the coefficient of log DEGRISK is not very precisely estimated, a consequence of using 2SLS.

than their counterparts in equations (D) and (C), suggesting that this equation is rather unstable, and that the equality restriction may play a role in “stabilizing” results.

These runs were repeated using the sample construction procedure of table 2 of the original Persson et al. article, where observations with zero WTP were kept in the usable sample and were replaced with WTP=2. As before, the dependent variable is log WTP. Results are shown in table 9.9.

Table 9.9. Dependent variable: ldwp (=log WTP). T statistics in parentheses. Persson et al. data.

	A OLS (n=676)	B OLS n=676	C OLS N=579	D OLS n=676	E 2SLS N=579
Intercept	0.8445 (0.40)	-1.0221 (-0.45)	-2.4185 (-0.97)	0.0810 (0.04)	-0.5672 (-0.18)
Log income per household member	0.3596 (2.32)	0.4213 (2.47)	0.4777 (2.50)	0.3747 (2.19)	0.4373 (2.19)
Log km traveled in car	0.5681 (3.75)	0.4949 (3.19)	0.4368 (2.60)	0.5502 (3.52)	0.6573 (2.47)
Log DEGRISK	0.0564 (-0.87)	0.1850 (2.32)	0.4092 (2.38)	0.0671 (0.73)	-0.6332 (-0.65)
Log RISKMD	0.5592 (3.46)	0.1850 (2.32)	0.4092 (2.38)	0.5467 (3.35)	0.4420 (2.47)
Injured in accident (Dummy)		0.3779 (1.58)	0.4372 (1.71)	0.3659 (1.53)	0.4262 (1.63)
Log age	-0.6677 (-2.53)	-0.4943 (-1.68)	-0.3308 (-1.03)	-0.5770 (-1.96)	-0.6910 (-1.48)
Log age squared	-0.0395 (-0.87)	-0.0085 (-0.17)	-0.0105 (-0.18)	-0.0211 (-0.42)	0.0350 (0.45)
High school diploma		-0.1275 (-0.47)	0.0829 (0.28)	-0.0635 (-0.23)	0.1567 (0.50)
College degree		0.1298 (0.47)	0.3539 (1.16)	0.1627 (0.59)	0.3249 (1.03)
Household members ages 0-3		0.1754 (0.75)	0.1008 (0.42)	0.1441 (0.62)	0.0552 (0.22)
Household members ages 4-10		0.2401 (1.59)	0.3410 (2.14)	0.2396 (1.60)	0.3088 (1.87)
Household members ages 11-17		-0.0445 (-0.26)	0.0366 (0.20)	-0.1594 (-0.09)	0.0269 (0.14)
Household members ages 18+		0.0543 (0.43)	0.1545 (1.14)	0.0372 (0.30)	0.1494 (1.07)
Test that b2=b3				F=6.44 P val=0.0114	F=1.18 P val=0.2776

Observations with missing baseline risk and missing WTP, observations with baseline risk smaller than 1 in 100,000, observations with WTP less than 1 and with WTP greater than 5% of annual income are excluded. Observations with WTP equal to zero are replaced by WTP=2.

As before, both OLS and 2SLS estimation confirms that WTP increases less than proportionately with the absolute risk change, the coefficient on log ABSRISK being less than 1 (0.18 and 0.40, respectively). However, WTP is more responsive to the change in

risk, as shown by both the magnitude and the significance of the coefficients. As before, the instrumental variable procedure results in a stronger coefficient on risk.⁴³

Regarding the question whether WTP depends on absolute or the relative risk reduction, specifications (D) and (E) suggest that WTP is associated with the relative risk reduction. When the 2SLS estimation procedure is used, however, we cannot reject the null hypotheses that the coefficients of log DEGRISK and log RISKMD are equal, despite the fact that individual t statistics indicate that the former is insignificant, while the latter is strongly statistically significant.⁴⁴

The regressions of this section were repeated after the sample was allowed to include persons whose WTP exceeds 5% of household income but is less than 12.5% of household income. If zero WTP responses are discarded, the coefficient on log absolute risk is 0.15 when subjective risk is treated as exogenous, and 0.21 with 2SLS. Both coefficients are been significant at the 5% level. If zero WTP is replaced by WTP=2, then the elasticity of WTP with respect to absolute risk reduction is equal to 0.30 when OLS is used, and to 0.51 when 2SLS is used.

As we pointed out in section B of this chapter, respondents in this study were first asked to report their WTP for a reduction in their own risk of dying for any cause. The risk of dying for any cause, AEGRISK, is well predicted by age and by the respondent's self-assessed health on a scale from 0 to 100, but there is little evidence of a relationship between WTP and absolute risk, whether or not we treat AEGRISK as endogenous with WTP. The test of the null hypotheses of exogeneity of AEGRISK does not reject the null at the conventional levels.

G. Robustness of results to excluding large subjective risks

⁴³ To test the null of exogeneity of log subjective risk, we enter the residual from the first-stage regression of log DEGRISK on a set of instruments (regression reported in table 9.8) in the right-hand side of the equation for log WTP. When log DEGRISK and log RISKMD are restricted to have equal coefficients, the test of exogeneity, which is the t statistic for the coefficients on these residuals, is -1.85, which rejects the null at the 10% level, but not at the 5% level. When log DEGRISK and log RISKMD are allowed to have potentially different coefficients, the test of the null of exogeneity is -0.85, which does not reject the null at the conventional levels.

⁴⁴ We also repeated the regression of table 3 of the Persson et al article, which relies on the sample used for table 8, and on a linear model of WTP. We specified WTP to be a linear function of income per household member, kilometers traveled by car in one year, absolute risk reduction, education dummies and variables measuring the numbers of children and adults in the household. While WTP is well predicted by income and kilometers traveled by car, the OLS estimate of the coefficient on absolute risk reduction is *negative* and very small (-0.077) and statistically insignificant (t statistic -0.76). Two-stages least squares result in an estimate that has the correct sign (71.27) and a somewhat better significance level (t statistic 1.67).

Table 9.10 reports regression results based on the full set of data cleaning criteria devised by Persson et al., including the requirement that respondents with absolute risk reductions greater than 10 in 100,000 be excluded from the sample.

In column (A), we report the OLS regression in table 1 of the Persson et al. article. Column (B) reports the results of a specification that includes absolute risk reductions as well as other variables. As mentioned, one would expect the coefficient of the risk reduction to be positive and significant if WTP is to satisfy the scope effect requirement (i.e., WTP must increase with the size of the absolute risk reduction) and if a VSL is to be computed based on the survey responses. The specification in column (B) also controls for other individual characteristics of the respondent thought to influence WTP.

Despite repeating exactly the same data cleaning as in Persson et al., the sample size I obtained is larger than that in the Persson et al paper, and the regression coefficients somewhat different. Restricting the coefficients of log RISKMD and log DEGRISK to be equal, which implies that log WTP depends on log ABSRISK, and treating DEGRISK as exogenous, results in a regression coefficient on log ABSRISK of about 0.15. This time, the instrumental variable procedure results in an even *smaller* coefficient on log ABSRISK, and in a weaker statistical association with log WTP (the t statistics dropping from 2.15 to 1.65). This suggests that WTP increases only weakly with the size of the risk reduction, and is, again, less than proportional to it. Further inspection of table 9.10 reveals that there is little evidence that the subjective risk is endogenous with WTP, and that people respond differently to baseline risk and relative risk reductions.

When the sample is augmented by including observations where WTP was originally zero, and has been recoded to 2, the results (shown in columns (D)-(E) of table 9.10) suggest instead that individual *do* respond to absolute risk reductions. Evidence that subjective risk is endogenous is still relatively weak (the t test on the residuals from the first-stage residuals from the log DEGRISK equation is only -1.83), but the 2SLS procedure results in a coefficient on log absolute risk that is 50% larger than its OLS counterpart.

What emerges from this section is, therefore, that it is important to test for possible endogeneity of subjective risks with WTP. It is also important to check for implausibly large and small risk values, and to keep in mind that excluding such risk values from the sample tends to affect the results. Regression relationships, however, do not necessarily become more stable, or result in more significant associations with WTP, once the sample is purged of very large subjective risk values. In some cases, this could be due to the loss of variability in one of the key regressors of WTP.

Table 9.10. Dependent variable: ldwp (=log WTP). No observations with absolute risk reduction greater than 10 in 100,000. T stats in parentheses.

	Zero WTP excluded			Zero WTP replaced with WTP=2		
	A Persson et al. (OLS) (N=439)	B Alberini, exogenous risk (OLS) (N=557)	C Alberini, endog. risk (2SLS) (N=481)	D Persson et al. (OLS) (N=662)	E Alberini, exogenous risk (OLS) (N=642)	F Alberini, endog. risk (2SLS) (N=550)
Intercept	3.1714 (3.13)	0.4085 (0.29)	-0.2515 (-0.17)	5.324** (2.45)	-0.4279 (-0.18)	-1.7805 (-0.69)
Log income per household member	0.237* (3.22)	0.2206* (2.15)	0.2808** (2.48)	0.298^ (1.76)	0.3845* (2.16)	0.4237* (2.14)
Log km traveled in car	0.475** (3.28)	0.3265** (3.32)	0.2742** (2.78)	0.607** (2.49)	0.5134** (3.21)	0.4626** (2.71)
Log RISKMD	0.183* (2.06)			0.393** (2.58)		
Log DEGRISK				0.217** (2.67)		
Log ABSRISK		0.1488* (2.15)	0.1659^ (1.64)		0.3057** (2.58)	0.4535** (2.59)
Injured in accident (dummy)	0.286 (1.92)	0.1453 (1.03)	0.2553^ (1.72)		0.3274 (1.33)	0.4301^ (1.66)
Log age		0.2093 (1.13)	0.2576 (1.32)	-0.791** (-2.73)	-0.5661^ (-1.85)	-0.3675 (-1.11)
Log age squared		0.0042 (0.14)	0.0090 (0.27)	0.217** (2.67)	-0.0178 (-0.35)	-0.0093 (-0.17)
High school diploma		0.2362 (1.45)	0.2430 (1.36)		-0.0217 (-0.08)	0.1848 (0.61)
College degree		0.2687 (1.63)	0.2235 (1.23)		0.2017 (0.71)	0.4032 (1.30)
Household members ages 0-3		-0.0010 (-0.01)	-0.0106 (-0.12)		0.1471 (0.62)	0.0782 (0.32)
Household members ages 4-10		0.0957 (1.07)	0.1271 (1.36)		0.1849 (1.18)	0.2617 (1.58)
Household members ages 11-17		-0.1264 (-1.24)	-0.0807 (-0.80)		-0.0799 (-0.46)	-0.0242 (-0.13)
Household members ages 18+		0.1598* (2.09)	0.2040** (2.50)		0.0290 (0.22)	0.1430 (1.03)
Test of the null of exogeneity of subjective risk			-0.90 does not reject null			-1.83 rejects null at the 10% level
Test of the null that b2=b3			F=2.40 Pval=0.12			F=0.09 Pval=0.77

Note: the Alberini specifications restrict the coefficients of log RISKMD and log DEGRISK to be equal, which means that log ABSRISK is entered in the equation.

Conclusions

- When baseline risks and the risk reductions are subjectively reported by the respondents, it is important that regressions be run that relate WTP to the size of the risk reduction.
- These regressions should test for the possible endogeneity of the risks, or risk reductions, with WTP. In one of the two applications examined in this chapter, there was no evidence of endogeneity of baseline risks and WTP. In the other, there was evidence of such endogeneity, and the coefficient on log absolute risk increased when these two variables were explicitly treated as endogenous, providing support to the notion that WTP does increase with the risk reduction (sensitivity to scope).

10. SAMPLE SELECTION ISSUES

Chapter 2 discussed possible ways to control for sample selection issues. In practice, although a number of studies appear to have at least checked for possible self-selection bias (including Gerking et al., 1988, Lanoie et al., 1995, Persson et al., 2001, and Corso et al., 2001), we have not been able to obtain the variables that are necessary to run our own models of participation into the survey.

Gerking et al.'s study used a mail survey to elicit information about WTP and WTA for changes in occupational risks. The survey questionnaires were mailed to a random sample of 3000 US residents, and to an additional sample of 3000 respondents, randomly selected among the residents of 105 US counties with disproportionately large concentrations of high-risk industries. The ages, income, education levels, and other characteristics of those who elected to fill out and return the questionnaires can therefore be compared with those of the US population, using Census and Current Population Survey data. If the researchers kept track of the addresses of the mail questionnaires who did not return the questionnaire, it would have been possible to check, using multivariate probit regressions, whether participation in the survey is more likely in areas—such as Census tracts, zipcodes or counties—where the residents have certain characteristics. Indeed, some analysis along these lines were reported in Gegax et al. (1987), the article on the companion compensating wage study, but the data are no longer available for our use. Gegax et al. (1985) also plot the response rate against the day of the study, and the baseline risks of the samples from the general population, and from the residents of the counties with high concentration of risky industries.

Similarly, Persson et al. mail questionnaires to a random sample of Swedes of ages 18-74. The first mailing of the questionnaire was in March 1998, and was followed by two follow-up remainders in hopes of raising the return rate. The overall return rate is 51%. In addition, to check for possible selection into the sample, the authors sent out 2645 “drop out” questionnaires, 659 of which were eventually filled out and returned. The authors conclude that the final sample is wealthier, drives more miles, and has a higher educational attainment than the average Swede and the typical dropout respondent, but that it does not differ from the Swedish population and dropout respondents in terms of gender and access to a car.

Corso et al. (2001) check that if samples of respondents that received survey materials with different visual aids have similar individual characteristics. Since they find that the composition of the samples is similar, this allows them to conclude that any differences in WTP must be attributed to the experimental treatment, which is the type of visual aid.

11. QUESTIONNAIRES

We examined four questionnaires from selected CV studies about mortality risks. We present a detailed discussion of these questionnaires in Appendix C, and the questionnaires from selected CV surveys are included in Appendix D. Two of these questionnaires (Johannesson and Johansson, 1996; Johannesson et al., 1997) were administered over the phone. Persson et al. and Gerking et al. conducted mail surveys, while the Corso et al. questionnaire was administered through (i) an initial phone contact, (ii) mailing of survey packets, and (iii) phone re-contact to elicit the answers to the questions. By contrast, Krupnick et al. brought respondents into a centralized facility to take a self-administered computer survey, and in Alberini et al. the same questionnaire was administered by Web-TV.

Inspection of these questionnaires reveal that they are very different in length. For example, the Johannesson and Johansson (1996) and the **Johannesson** et al. (1997) questionnaires are short, contain no warm-up questions, and jump right to the matter at the heart of the study—an extension in expected remaining lifetime at age 75, and a reduction in the risk of dying over the next year, respectively. The fact that the survey was done over the phone precludes the use of visuals to depict risks. Respondents are not asked to practice with the concept of probability, and no debriefing questions are asked to test comprehension of probabilities and acceptance of the scenario. Information about education, income and other basic sociodemographics characteristics of the respondent is gathered, but there are no questions about risk reducing behaviors or attitudes.

Even more important, people are told that about the probability of dying, presumably for all causes, but the risk reduction is described as delivered by a medical intervention, without explaining which illnesses or cause of deaths this medical intervention would address. Finally, it is not clear whether the payment would be out of one's pocket, would be in the form of a copay to the national health care system, or could have been construed to be entirely covered by the national health care system. The questionnaire does not investigate reasons for answering either “yes” or “no” to the payment questions, but does ask whether people were absolutely certain that they would make the payment.

The **Persson** et al. questionnaire is a nice example of a mortality risk questionnaire. The context is road transportation risks, and the questions were asked in such a way that virtually no skip pattern (which is sometimes confusing in a self-administered mail survey) had to be created. For example, people were asked to indicate their own risk, and the risk reduction was a specified percentage. Respondents, however, are not explicitly instructed to write down the absolute risk change corresponding to the indicated percentage (e.g., “30% risk reduction, implying that your risk would be reduced by ____”), which could be one of the reasons why—as shown in section 9—people may have paid more attention to the percentage *per se*, rather than the absolute risk reduction.

One attractive feature of this questionnaire is before assessing their subjective risks the respondents are instructed to think of their own health, miles traveled, and how they

drive. Presumably, they were already focused on the latter, since they had answered several questions about them.

Another attractive feature of the Persson et al. questionnaire is that respondents are shown the risks of death for all causes for a reference person (a 50-year old) on graph paper, with areas of different shades of gray representing the risks of dying for various causes, such as heart diseases, cancer, and traffic accident. These were annual risks, expressed as X in 100,000, and shown on graph paper.

The questionnaire begins with simple questions about the use of safety devices (such as seatbelts and bike helmets), moving quickly through detailed questions about commuting and travel patterns for each possible mode of transport, broken down by winter and summer. Three questions are dedicated to finding out whether the respondent has been in a transportation accident, and how recently.

Just before the risk information portion of the survey, people are asked to assess their own health status using the “health thermometer.” This device appears simple and appropriate for a mail survey where the main focus is the risk of dying in road traffic accident. (It would be too simple, and not disaggregate enough to be able to establish the relevant health status, in a survey about risks from heart disease, for example.)

The risk reduction is a private commodity and the risk reduction scenario is abstract. This has the advantage of keeping respondents focused on key aspects of the risk reduction itself (e.g., one year only, death risks only, risk reduction for the respondent only, no inconvenience associated with the use of safety devices) and on their budget constraint. This abstract scenario seems well suited for valuing traffic-related risks, where it has the additional advantage of potentially catering to other modes of transportation, and not just to automobiles.

By contrast, the abstract risk reduction scenario posited for the general risk reduction is unconvincing. Blending “safety equipment and preventive health care” seems a rather vague way of promising a reduction in one’s overall risk of death. Perhaps this is one reason why WTP for a change in the overall risk of death fails to be significantly related to the size of the risk change.

This questionnaire took great pains to remind respondents to consider their budget constraint when answering the WTP questions, and reinforced this notion after the WTP questions by asking respondents to indicate how they would reallocate the household’s expenditures to afford to pay for the risk reduction.

The questionnaire used for the **Corso** et al. study varied the visual aids across respondents in order to find out what works best for communicating risks, measuring performance in terms of internal validity of the WTP responses. The questionnaire itself, however, is comprised of six sections that value risks of completely different nature, including the risk of (i) contracting and dying for a rare but serious foodborne illness, (ii) dying in an auto accident, and (iii) contracting hepatitis and HIV through blood

transfusion. The questionnaire also elicits WTP for (iv) an extension in remaining expected life time, or a reduction in the risk of dying at various ages, via a pneumonia vaccine.

It would seem difficult for most people to be able to move through so many risk reductions and to place a value on them within a single survey instrument. Moreover, the magnitude of the risks varied from one section of the questionnaire to the next, ranging from X in 10000 to X in a million. The blood safety of the questionnaire described the risk of contracting hepatitis through a transfusion as X in 10000, and the risk of contracting HIV as X in a million. The former was then re-stated as 100X in a million. Keeping a track of all of this would seem rather difficult even for mathematically talented respondents with the survey materials in front of them.

Regarding the visual aids, risk ladders are generally useful in assessing the magnitude of risk changes, but the ones used in this questionnaire are a bit cluttered and the information about the “community risk” equivalents (e.g., 1 in 1000 is one in a village) is distracting. It is, therefore, not surprising that more abstract ways to depict risks seemed to have worked better.

The **Gerking** et al. and the **Lanoie** et al. questionnaire focus on workplace risks and are relatively similar to one another. After eliciting initial information about the occupation and industry of the respondent, Gerking et al. inquire about the respondent’s subjective assessment of various types of occupational risks, ranging from fires and explosions to the risk of being crushed by equipment. They use a risk ladder to elicit the respondent’s subjective assessment of his or her own workplace risk.

The ladder represents risks ranging from 1 to 10 in 4000 per year, with each step of the ladder representing a 1 in 4000 increment in risk, and respondents are asked to indicate on a payment card the amount they would give up (accept) in earnings to reduce (increase) risks by one step. The risk ladder is simple, clear, and easy to interpret. The risk reduction is abstract, in the sense that no specifics are provided to indicate how exactly the risk reduction would be attained. We did not find this to be a problem, and we thought it actually helped keeping the respondent focused on the risk reduction *per se*. Extensive questioning is dedicated to wages, income, other aspects of the workplace and occupation, experience, and education.

The Lanoie et al. adopts the risk ladder approach, but with revised risk figures, and could be considered as a more streamlined variant of the Gerking et al. questionnaire. It differs from the latter in that respondents are educated about risks using an auto safety example, and that hypothetical questions are included that elicit WTP for a reduction in occupational risks by 2 in 10,000. An advantage of this questionnaire is that the respondent is clearly told that the risk reduction would halve the baseline risk. The questions about hypothetical risk reductions ask respondents to imagine being construction workers (or other high risk occupation) facing a specified risk level.

Conclusions

- Visual aids should be as simple and uncluttered as possible. In one instance, additional details that were meant to help understand the magnitude of the risks were, in fact, distracting.
- In some cases, it may be possible to successfully craft abstract or stylized risk reduction scenarios. The advantage of abstract risk reduction scenarios is that they help keep the respondent focused on the magnitude of the risk and risk reductions, without being distracted by other concerns, such as the specifics of the risk reduction delivery mechanism.
- The survey instrument should not attempt to elicit WTP for several types of risk reductions, e.g. risks in the transportation and food safety contexts. These risks are likely to differ in magnitude and to require setting up alternative hypothetical scenarios, resulting in (i) a heavy cognitive burden on the respondent, (ii) the possible loss of credibility of the survey, and (iii) diminished focus and increased fatigue on the part of the respondent.
- Survey instruments that focus on WTP for reductions in the risk of dying for specific causes (e.g., auto accident, or heart disease) should also educate the respondent about the magnitude of these risks when compared to other causes of deaths.
- When stating the risk reduction to the respondent, it is important to also explain what percentage of the baseline risk this reduction represents.

12. CONCLUSIONS

This research project has re-analyzed the data collected through a number of contingent valuation studies eliciting WTP for mortality risk reductions. It has also collected questionnaires and survey materials. Our conclusions are as follows.

1. Given that the estimates of the VSL and the WTP regression coefficients are often sensitive to the specification of the model, it is imperative that the data collected through contingent valuation studies be archived with full documentation for possible re-examination on the part of the Agency.
2. When one-shot dichotomous choice questions are used to elicit information about WTP, the estimates of mean WTP can be large and unreliable, even if the sample size is large, when one works with a skewed distribution of WTP.

This is because of three concurrent factors. First, the estimate of mean WTP depends crucially on the shape of the upper tail of the distribution of WTP. This means that any distributional choices that do not match well the observed frequencies may have a large effect on the estimates of mean WTP. Second, the estimates of mean WTP are sensitive to the more or less complete coverage of the range of WTP by the selected bid amounts. Third, outliers can dramatically alter the estimates of mean and median WTP.

When one works with symmetric distributions of WTP, in some cases (i.e., when many “no” responses are observed for low bid values) the estimated mean is negative.

These difficulties suggest that information about WTP should be refined using follow-up questions, although we recognize that doing so may no longer constitute an incentive-compatible elicitation procedure.

3. Median WTP is more robust to the choice of the distributional assumption, to outliers, and to the possible presence of undesirable response effects, such as completely random responses to the payment question, than mean WTP. This result is not unique to CV surveys about mortality risks. Choosing median WTP is justifiable in that it has a natural majority vote interpretation, from a welfare perspective it provides a more conservative measure of the VSL.
4. Contingent valuation researchers (Carson, 2000) worry about the presence of “yea-sayers,” “nay-sayers,” and persons who provide completely random responses. In this research, we attempted to account for their presence using (discrete) mixture models that do not rely on or require any additional information coming from the responses to debriefing questions or other questions in the survey. In practice, these models often failed to identify any contaminating component. When they did, they pointed to an implausibly high likelihood that an observation reflects one of the abovementioned undesirable response behaviors.

These findings should be interpreted in the light of related research (Alberini and Carson, 2001) suggesting that identification of mixtures with yea-saying etc. is difficult, and works well only when the mixture is specified correctly, and the contaminating component is not negligible. This suggests that questionnaires incorporate questions that aid in identifying potential yea-sayers, etc. and that the econometric analysis examines alternate usable cleaned samples on the basis of the answers to these questions.

5. Researchers should check for observations such that WTP accounts for a large share of household income. In addition to increasing the estimates of mean WTP, these observations may affect the estimate of income elasticity of WTP.

Large WTP amounts relative to one's income could be caused by respondent failure to understand aspects of the provision of the risk reduction, failure to give proper consideration to the budget constraint, or poor measurement of income. Reminders of the budget constraint before the valuation question and instructions on how to compute total personal or household income may alleviate some of these problems. These reminders will not, however, prevent a small percentage of respondent from deliberately misreporting their income. Auxiliary regressions of income on education and age may help uncover some of these problems, and suggest that aberrant observations be excluded from the sample, or their income replaced with an imputed value.

6. When respondents are asked to estimate their own subjective risks and/or risk reductions, it is important to check whether WTP and subjective risks are endogenous. Endogeneity in this case would be driven by the presence of unobserved individual factors that are common to both WTP and subjective risks. In one of the two examples presented in this report, we found that accounting for endogeneity of risks and WTP improved the sensitivity of WTP to the size of the risk reduction, which is an important internal validity criterion.

7. Researchers have typically asked respondents in a contingent valuation surveys to value risk reductions expressed in one of two possible ways. The first is an absolute risk reduction (e.g., 5 in 10000), and the second is a relative risk reduction (e.g., reduce the baseline risk by 30%). The analysis of the Persson et al. data, where the risk reduction was expressed as a stated percentage of the subjective baseline risks, suggests that WTP was driven by the relative risk reduction, and not by the absolute risk reduction. This is problematic, because it is not clear how VSL would be calculated.

We would recommend that researchers express risk reductions in both absolute *and* relative terms. For example, they may say that the risk reduction is "5 in 10000. This represents a 30% reduction in your risk of dying." Of the questionnaire that we examined, only one, the Lanoie et al. questionnaire, explicitly reminds respondents that 2 in 10,000, the risk reduction they are to value, is a 50% risk reduction, since the baseline is 4 in 10,000.

8. We endorse the practice of showing the respondents one's risk of death for a specific cause (e.g., traffic accidents) in the context of the risk of dying for all causes, and for other specific causes. This was done, for example, in the Persson et al. questionnaire.

9. A number of studies ask people to rate their health, using a scale from 1 to 10 (Johannesson et al., 1997) or 0 to 100 (Persson et al., 2001), or response categories like "excellent," "very good" etc. relative to other people the same age. For the most part, current health has not proven to be a strong predictor of WTP, although it generally correlates well with one's own subjective risks of dying.

If, for policy purposes, it is deemed important to see if WTP for risk reductions depends on health status, future studies might consider oversampling among the chronically ill or persons with specified ailments to maximize the "contrast" with respect to the rest of the population. If possible, this stratification of the sample should be done on the grounds of physician-diagnosed illnesses, rather than on the basis of self-assessed health status.

10. Comparison of the visual aids used in various studies (e.g., Corso et al., Persson et al., Krupnick et al.) suggests that it is best to keep the visual depiction of risk as simple as possible. We appreciate the effort by Corso et al. to help the respondent digest the magnitude of the risks by thinking of the frequency of deaths in a community of the appropriate size, but we found the added icons and language distracting.

11. Mortality risks can be a delicate matter. We prefer to avoid mentioning the risk of dying in the title of the survey instrument or on the cover page of the questionnaire. This is better left to the middle of the survey, after the respondent has been "warmed up" and guided through exercises about probabilities. Focus groups and qualitative research should be devoted to finding out how risks can be presented in a non-offensive, meaningful way to minorities and the elderly.

When the Krupnick et al questionnaire was administered, after being translated into Italian, to a sample of Italians, several of the elderly respondents that had been recruited for the study left in the middle of the survey, feeling offended by the topic of the survey (death).

12. Mortality risk reduction scenarios can frame the risk reduction to be delivered by a public program, or as a private good. When choosing the private good route, it is important to craft the scenario in such a way that the respondent does not question the legitimacy, social and medical acceptability of the proposed risk reduction. To elaborate on this matter, it seems surprising that the Johannesson et al (1997) questionnaire mentions a medical intervention that would reduce the risk of dying, but does not reassure respondents that this is approved by the national health care system, and does not say anything about the payments being out-of-pocket, co-pays, etc.

13. When attempting to answer questions about the relationship between WTP and, say, age, researchers should keep in mind that results can be affected by the choice of the econometric model (e.g., the distribution of WTP) and of the welfare statistic. For

example, the curvature of the inverted-U shape identified by Johannesson et al. (1997) would have been much more pronounced, with the elderly reporting much lower values than people in their 40s, had they used a lognormal distribution of WTP, and had they focused on median WTP, instead of mean WTP.

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Appendix A.

Summaries of Articles.

Summary form 1

Author(s)	Persson, Ulf, Anna Norinder, Krister Hjalte and Katarina Gralen
Year of publication	2001
Title	“The Value of a Statistical Life in Transport: Findings from a New Contingent Valuation Study in Sweden”
Journal	Journal of Risk and Uncertainty, 23(2), 121-134.
Valuation method	contingent valuation
Type of risk valued	risk of death in transportation accidents (road traffic) and risk of non-fatal injury in road-traffic accidents
Magnitude of the risk	baseline risk expressed as X in 100,000 per year
Magnitude of the risk reduction	X in 100,000 annual
Population	adults in Sweden ages 18-74
Sampling frame	not specified
Survey method	mail
Response rate	5650 questionnaires mailed out; two reminders; 2884 returned questionnaire, for a return rate of 51%. There was a “drop out” questionnaire (an in-depth follow-up for those respondents who did not return the questionnaire after the first mailing?), which resulted in 659 answered drop out questionnaires.
When	first mailing in March 1998
WTP elicitation method	open ended
Subjective or objective baseline risks?	Both. Respondents were told what the risks for the average person their gender and age are, but then are asked to report their perceived risks, considering how often they are exposed to traffic, distance traveled, mode of transport, and how safely the respondent drives.
Commodity being valued	reduction in the risk of death. The paper is somewhat ambiguous about this, but from communications with the authors it would appear that the

risk reduction to be value is Z% risk reduction from the subjectively assessed baseline risk. Private risk reduction, to be attained by wearing a special device. The payment is intended for one year only, and the risk reduction delivered by the device is for one year only.

Risk communication Grid of 100,000 squares, with black squares representing deaths

Is the questionnaire reported in the article? No—received questionnaire from authors. Questionnaire is in Swedish and is being translated into English.

Is questionnaire Available to us? yes

Experimental Design Two independent subsamples. First subsample values a reduction in the risk of death in road traffic accident. Second subsample values a reduction in the risk of non-fatal injuries in road traffic accident. Of the 2884 returned questionnaire, 935 were about fatal risks, and the remaining (2884-935) were about risk of non-fatal injuries. The paper only reports the results of the mortality risk component of the study (subsample 1).

Within subsample 1, respondents were randomly assigned to one of four possible groups, each group being given a different percentage risk reduction. The proportional risk reductions being assigned to respondents are 10%, 30%, 50% and 99%.

In addition, subsample 1 was further subdivided into other groups (presumably, in a manner that is orthogonal to the proportional risk reduction treatment) to test other effects, but no details are reported in the paper about this additional experimental treatments.

Bid Design not applicable (WTP question is open-ended)

Statistical model(s) to estimate mean or median WTP Since WTP is a non-linear function of the absolute risk reduction, mean WTP and hence VSL is predicted for absolute risk reductions of various sizes using a regression model (see below)

WTP Regressions? Yes. Two types of regressions. The first type is a regression model where the dependent variable is logWTP. Both a semi-log and a log-log specification are reported.

The semi-log model only uses observations with WTP>1 SEK (n=439). In the log-log model, zero WTP observations are replaced by a small positive number, and then the log transformation of all (original and revised) WTP amounts is taken (n=662).

The second type is a LAD regression, where the influence of outliers (zero WTP amounts and large WTP amounts) is reduced. This second regression relates WTP to the absolute risk reduction. The absolute risk reduction is equal to (subjective baseline risk \times exogenously given percentage risk reduction). N=675.

Regressors Subjective baseline risk, percentage risk reduction, age, age square, income, miles driven or ridden in a car, dummy for prior accident experience (in various combinations, depending on the specification)

Results Based on the more complete specification for the log-log regression, WTP is significantly related to subjective baseline risk and risk reduction, and the coefficients of these variables are positive, as expected. WTP also grows with household income and miles driven, and has an inverted-U relationship with age. The income elasticity of WTP is 0.3, which is in line with other studies of this kind. The semi-log specification suggests that previous accident experience raises WTP, as does the number of miles driven.

The results of the LAD regression suggest that the slope of the relationship between absolute risk reduction and WTP is very steep for very small risk reductions, implying that for very small risk reductions some people will report zero WTP amounts and others will report positive WTP amounts. The function flattens out at higher absolute risk reductions. The results of the LAD model are used to compute WTP, and hence risk reduction, for various levels of absolute risk reductions.

Implied VSL WTP, and hence VSL, is calculated for various absolute risk reductions. Hence, this study does not result in a unique VSL figure. The authors comment that the figure that is closest to the needs for policy purposes is that for risk reduction of 2.4 in 100,000. They also comment that VSL figures are in line with those for US studies and Viscusi's acceptable range.

	$\Delta R=1.8$ in 100,000	$\Delta R=2.4$ in 100,000	$\Delta R=5$ in 100,000
VSL in million Swedish Kroners (SEK)	30.38	24.01	13.17
VSL in million US dollars*	3.59	2.84	1.56

*The exchange rate used in the paper is 6.6 SEK to 1 US dollar.

Other * The final survey was preceded by a 280-person pilot.

* The authors use the sample that excludes respondents whose WTP is greater than 5% of annual household income.

* Analysis of sample selection bias: the sample has higher income, education, miles driven than the Swedish average and than the people who did not return the survey

questionnaire. Access to a car and gender in the sample are roughly the same as for the average Swede. Women tend to drop out (not return the questionnaire) more than men.

* The average subjective risk was 11 in 100,000. This is almost twice as much as the average (objective) risk in Sweden, which is 6 in 100,000. Median subjective risk, however, is 3 in 100,000.

* Using income elasticity of WTP, which is 0.237 based on table 1 (but 0.298 based on table 2) the authors estimate that WTP would decrease by 7% if the sample's income was more in line with the Swedish average. Since the average income in the sample is about 30% greater than the Swedish average, the calculation is $0.3 \times 0.237 = 0.0711$.

* The specification searches in the regressions were done using stepwise regressions.

* Robustness checks were done by dropping, in turns, one of the groups with specified percentage risk reductions (e.g., the 99% risk reduction group).

Limitations of the Study

Econometric analysis: (1) The subjective risk is entered as a regressor in the WTP equation, but authors do not check if it is simultaneously determined with WTP (possible endogeneity bias). We will attempt to do this if

we get the complete dataset.

(2) Somewhat unsatisfactory treatment of the zero WTP responses, which account for 16.81 percent of the sample.

(3) No attempt to identify determinants of zero WTP responses.

Summary form 2

Author(s)	Johannesson, Magnus and Per-Olov Johansson
Year of publication	1996
Title	“To be or Not to Be, That is the Question: An Empirical Study of the WTP for Increased Life Expectancy at an Advanced Age”
Journal	Journal of Risk and Uncertainty, 13, 163-174.
Valuation method	contingent valuation
Type of risk valued age 75	An extension of one year to the expected remaining life at age 75
Magnitude of the risk	the probability of surviving to age 75 is expressed in percentage terms (e.g., 75 percent for a woman of age 18-39)
Magnitude of the risk reduction	Not a risk reduction. The good to be valued is a one-year extension in remaining lifetime at age 75.
Population	Adults in Sweden ages 18-69
Sampling frame	“Random sample of individuals in the age 18-69 group.”
Survey method	Telephone.
Response rate	82% (2455 contacted, 2013 completed surveys).
When	June 1995
WTP elicitation method	Single-bounded dichotomous choice. In addition to offering the standard response categories (yes and no), people were subsequently asked whether they felt “totally sure whether they would pay or not.”
subjective or objective baseline risks?	Objective. The probability of surviving to age 75 is given For the average person of the respondent’s age and gender.
Commodity being valued	A one-year extension of the expected remaining life at age 75, which is 10 (hence the respondent, if he or she reached age 75, would expect to live an additional 11 years). This extension would be obtained through a <u>privately</u> purchased medical treatment.

Is the questionnaire**reported in the article?**

No, but the payment question is reported: “The chance for a man/woman of your age to become at least 75 years old is X percent. On average, a 75-year-old lives for another ten years. Assume that if you survive to the age of 75 year you are given the possibility to undergo a medical treatment. The medical treatment is expected to increase your expected remaining length of life to 11 years. Would you choose to buy this treatment if it costs SEKC and has to be paid for this year? Yes/no”

Do we have questionnaire**Available to us?**

Yes, in Swedish (to be translated)

Risk communication

No visuals (the survey was done over the telephone).

Experimental Design

The probability of surviving to age 75 is assigned to each person, and varies with age and gender.

Bid Design

Six bid values: 100, 500, 1000, 5000, 15000, and 50000, equivalent to about 14, 69, 138, 689, 2069 and 6896 US dollars at the exchange rate of August 1995, which is 7.25 SEK to 1 US dollar). Bids cover only upper tail of the distribution of WTP, since the percentage of “yes” responses to the bid amount varies from 53% to 9%.

Statistical model used**To estimate mean or****Median WTP**

The authors first fit a standard logit model of the yes/no responses, the bid value being the only regressor. Then they compute the expected value of WTP, conditional on WTP being positive. The expression for mean WTP based on this approach is $(-1/\beta)\ln[1 + \exp(\alpha)]$, where α is the logit intercept and β is the coefficient on bid from the logit model.

In practice, given their interest in the relationship between WTP and age of the respondent, they estimate mean WTP using this approach for each of three age groups, after separating the sample into the three groups and fitting separate logit regressions.

All regressions were done using the yes/no responses, plus conservative recodes (only those people who said that they were sure that they would pay were assigned a “yes”).

WTP Regressions?

Yes. Standard logit model with bid plus other regressors (see below).

Regressors

Bid, age, personal income, education, and gender.

Results

The logit regressions indicate that the likelihood of answering “yes” to the payment question is significantly and negatively related to the bid level (as expected), positively and significantly related to age, positively and significantly

related to income, and positively and significantly related to an education (dummy equal to one if respondent has at least completed high school). Gender was insignificant.

Implied VSL

Using the standard yes/no responses and the parametric approach based on the logit, mean WTP is predicted to be 8113 SEK in the 18-34 age group, 10208 SEK in the 35-51 year-old group, and 11707 SEK in the 52-69 year old group. (The age cut-offs for these groups were selected so as to ensure groups of roughly the same size.)

This is equivalent to US\$ 1119 (1995 dollars), 1408 and 1615, respectively, and to VSL (“according to a rough estimate”) of about \$93,000, \$106,000, and 121,000.

Average WTP for all sample is 9787 SEK, or \$1350 (1995 US dollars). This is roughly equivalent to a VSL of \$101,000.

Estimates based on conservative recodes are 25% to 60% the estimates based on the standard yes/no responses, depending on the age groups, whereas estimates based on a non-parametric approach (see Kristrom, 1990) are 70-80 percent those of the standard approach.

Other:

The authors also estimate the implicit discount rate, based on the comparison across WTP of respondents of different ages. Specifically, based on the standard responses and the logit-based approach, discount rates are 1.3 percent in the 18-34 age group, and 0.4% in the 35-52 age group. The discount rates are higher when the conservative recodes of the responses are used (roughly 3% in both groups).

Limitations of the study

* The survey was done over the telephone, so no visuals were used to aid in the explanation of the probability of surviving until age 75.

* People were not asked whether they accepted the baseline survival probabilities or though their own probabilities were higher or lower than the average person of the same gender and age. If people were thinking of different probabilities of survival than those stated to them in the survey, an econometric model relating WTP to baseline survival probabilities would suffer from the problem of regressors measured with errors, which typically results in downward biased estimates. It should be noted that the authors did not attempt this model.

* The explanation of the commodity is somewhat unclear, at least in English translation, and one wonders whether people may have thought of a certain extension of their lifetime, rather than a change in life expectancy. Also, the concept of life expectancy was not defined to the respondent.

* The bids are rather high, relatively to Swedish income, and one wonders whether asking people about bids this high may have created undesirable response effects.

- * The estimation approach for mean WTP is inappropriate. It first allows negative WTP values, and then sets them to zero, resulting in inflated mean WTP.
- * the questionnaire asks quality of life questions, but does not ask questions about the health status of the respondent, which could affect their acceptance of the survival probabilities.
- * no attempt to elicit subjective survival probabilities.

Summary form 3

Author(s)	Johannesson, Magnus, Per-Olov Johansson, and Karl-Gustav Löfgren
Year of publication	1997
Title	“On the Value of Changes in Life Expectancy: Blips Versus Parametric Changes”
Journal	Journal of Risk and Uncertainty, 15, 221-239.
Valuation method	contingent valuation
Type of risk valued	risk of dying over the next year
Magnitude of the risk by gender and age	baseline risk is expressed as X in 10,000 annual, and varies by gender and age
Magnitude of the risk reduction	2 in 10,000 over the next year for everyone in the sample
Population	adults in Sweden ages 18-74
Sampling frame	“Random sample of Swedes between the ages of 18 and 74 years”
Survey method	Telephone
When	Sept. to Nov. 1996
elicitation method	Single-bounded dichotomous choice
subjective or objective baseline risks?	Objective only. Respondents are told what the risks of death over the next year is for the average person of their gender and age.
Commodity being valued	A reduction of 2 in 10,000 from the (objective) baseline risk. The risk reduction is <u>private</u> and would be delivered by a treatment. The effect of the treatment is one year only.

This allows one to estimate the WTP for a reduction in the risk of death that lasts only in the year to come (“blip”). The authors also try to use the responses about WTP for the blip to infer the value of a “parametric change,” i.e., “a change in the hazard rate that pertains throughout

Is the questionnaire

reported in the article? No, but the WTP question is: “It is estimated that X(Y) men (women) out of 10,000 in the same age as you will die during the next year. Assume that you could participate in a preventive and painless treatment which would reduce the risk that you will die during the next year, but has no effects beyond that year. The treatment reduces the risk of your dying during the next year from X(Y) to X-2 (Y-2) out of 10,000. Would you at present choose to buy this treatment if it costs SEK I? yes/no”

Do we have questionnaire

Available to us? Yes, being translated from Swedish.

Risk Communication No visuals, as the survey was done over the telephone.

Experimental Design baseline risk varies systematically with gender and age; absolute risk reduction is the same for everyone.

Bid Design Six bids: 300, 500, 1000, 2000, 5000 and 10000 SEK, equivalent to US \$45, 76, 151, 303, 757 and 1515 (at the 1996 exchange rate of 6.6 SEK to 1 US \$). After 1000 surveys, the 2000 SEK bid was replaced by 10000 SEK. Bids cover only upper tail of the distribution of WTP, since the percentage of “yes” responses to the bid amount varies from 51% to 7%.

Statistical Model(s) The authors first fit a standard logit model of the yes/no responses, the bid value being the only regressor. Then they compute the expected value of WTP, conditional on WTP being positive. The expression for mean WTP based on this approach is $(-1/\beta)\ln[1 + \exp(\alpha)]$, where α is the logit intercept and β is the coefficient on bid from the logit model.

In practice, given their interest in the relationship between WTP and age of the respondent, they estimate mean WTP for various ages using the results of a logit regression (see below).

WTP Regressions? Yes. Logit regressions of the yes/no responses on various covariates.

Regressors Bid, age, age square, quality of life measure, household income, household size, gender, education

Results WTP in an inverted-U function of age, the highest WTP being at age 40. Income, size of the household and quality of life were not found to affect WTP. Education is negatively and significantly related to WTP, and males are willing to pay significantly less for the risk reduction.

Implied VSL WTP for the “blip” risk reduction of 2 in 10,000 is calculated for persons of age 20, 30, 40, 50, 60 and 70, as follows:

Age	Mean WTP in SEK (US \$ in parentheses)	Implied WTP in million SEK (million US \$ in parentheses)
20	6100 (924)	30.3 (4.59)
30	6900 (1045)	34.6 (5.24)
40	7200 (1091)	36.1 (5.47)
50	6900 (1045)	34.3 (5.19)
60	6000 (909)	29.8 (4.51)
70	4600 (697)	23.3 (3.53)
Average for entire sample	6300 (954)	31.4 (4.75)

The authors conclude that the VSL figures are roughly comparable to the range recommended by Viscusi.

Limitations of the Study

* No mention of debriefing questions to assess comprehension of risks and/or acceptance of the scenario And valuation exercise

* Survey was done over the telephone, precluding the use of visual aids to explain risks and risk reductions

* poor choice of econometric model for computing mean WTP

* failure to test for the relationship between WTP and baseline risks, and possibility that such an econometric model might be affected by an error-in-variable bias

* no mention of robustness checks in the article

Summary form 4

Author(s)	Johannesson, Magnus, Per-Olov Johansson, and Richard M. O'Connor
Year of publication	1996
Title	"The Value of Private Safety Versus the Value of Safety "
Journal	Journal of Risk and Uncertainty, 13, 263-275.
Valuation method	contingent valuation
Type of risk valued	risk of dying in a road traffic accident over the next year
Magnitude of the risk	baseline risk is the same for everyone in the sample; respondents were told the total number of people that die in Sweden every year in car accidents, but this number was not divided by the Swedish population to produce an individual risk of death figure.
Magnitude of the risk reduction	50% of the baseline risk. People were told that the "risk would be cut in half."
Population	Car owners in Sweden
Sampling frame	Random sample of Swedes between the ages of 16 and 74 years; only car owners were interviewed. 2000 people contacted, the final sample size (of car owners) was 1067
Survey method	Telephone
When	Sept.-Oct. 1995
elicitation method	Single-bounded (no follow-up), but there are three response categories: 1. no; 2. yes, fairly sure; 3. yes, absolutely sure
subjective or objective baseline risks?	Objective only. However, people are asked whether they think their risk is higher, the same as, or lower than the average driver.
Commodity being valued	Split sample study. One of the two independent subsample values a public program that reduces risk. Respondents are told that more resources would be devoted to preventing traffic accidents and are read a list of measures such as straightening bends, build safer crossings, etc. This would cut the annual number of fatalities in half.

The other subsample was asked to consider a special safety device, such as airbags, that would have to be installed each year to work, and would cut in half the risk of dying for the respondent and for everyone else traveling in the car. This is a private risk reduction and refers to annual risk.

The authors follow up on earlier research by Jones-Lee et al. (1985) and Viscusi et al. (1988) that focuses on altruism. To explore the issue of altruism, they also ask respondents whether they think they pay more or less than the average car owner. They also ask questions to find out whether the respondent thought the public program would have bring other benefits, in addition to the reduction in traffic fatalities. For example, if people thought that pollution would also be reduced by the program, they might be willing to pay more for the program than if they had not believed there would have been such a spillover.

Is the questionnaire

reported in the article? No, but the WTP question is. The text in brackets refers to the version with a public program to reduce risks: "In Sweden, 600 people die annually in traffic. A possible measure to reduce traffic risks is to equip cars with safety equipment, such as airbags. [We can devote more resources to preventing traffic accidents. We can, for instance, straighten out roads, build safer crossings, etc.] Imagine a new type of safety equipment. If this equipment is installed in your car, the risk of dying will be cut in half for you and everyone else traveling in the car [all road users]. This safety equipment must be installed each year to work. Would you choose to install this safety equipment in your car if it will cost you SEK B a year? Yes/no."

Do we have questionnaire

Available to us? No.

Risk Communication No visuals, as the survey was done over the telephone.

Experimental Design split sample to test difference in WTP between public program and private risk reduction.

Bid Design Six bids: 200, 1000, 2000, 5000, 10000 and 20000 SEK, equivalent to US \$30, 151, 303, 757 and 3030 (at the 1996 exchange rate of 6.6 SEK to 1 US \$).

The bids give a good coverage of the range of WTP values. For example, when attention is restricted to the sample valuing the private risk reduction, at 200 SEK 82% of the respondents is willing to pay the bid amount (66% is willing to pay and is absolutely sure about it), whereas at 20000 SEK only 9% is willing to pay the bid (1% if only absolutely sure responses are considered). Regarding the public program, 63% is willing to pay SEK 200 (43% if only absolutely sure responses are examined) and 3% at 20000 SEK (3% if only absolutely sure responses are treated as yes responses). This suggests that WTP for the private risk reduction is actually higher than WTP for the public program.

**Statistical Model(s)
To estimate mean or
Median WTP**

The authors fit an ordered logit model of the responses, the bid value being the only regressor, because there are three response categories, and these response categories are naturally ordered. The authors recognize that the estimated coefficients of the ordered logit model predict that a certain percentage of the respondents would have a negative WTP amount, but subsequently argue that WTP must be non-negative, at least for the private risk reduction. This leads them to computing $E(WTP)$ after truncating the distribution of WTP and restricting it to the positive semi-axis. The expression for mean WTP based on this approach is $(-1/\beta)\ln[1 + \exp(\alpha)]$, where α is the logit intercept and β is the coefficient on bid from the logit model.

WTP Regressions?

Yes. Ordered logit regressions of the responses on various covariates, including income, male, the bid amount, household size, age, education, two dummies constructed from the responses to the question about risk being the same as, lower or higher than the average driver, and two dummies based on the answer to the question about effects of the program on the environment. Separate regressions for the public and private risk reduction. Many of the covariates are insignificant. When the coefficients are significant, they seem to be different across the two equations (note that the specification is slightly different for public and private risk, because the questions about the effect of the program on the environment was asked only in the version of the questionnaire that dealt with the public program).

Regressors

Bid, age, income, male, household size, education, two dummies constructed from the responses to the question about respondent's risk as compared to the average driver, and two dummies based on the answer to the question about effects of the program on environmental quality.

Results

Two sets of estimates of WTP are produced. The first is based on the standard interpretation of the responses (whether fairly or absolutely sure, a yes is a yes), while the other is based on interpreting as yes only the absolutely certain responses. In both cases, mean WTP for the public risk reduction is lower than for the private risk reduction. Only when the conservative coding is used, however, is the difference in mean WTP statistically different.

Coding of the yes responses	(1) Mean WTP for private risk reduction	(2) Mean WTP for public program delivering risk reduction	Are (1) and (2) statistically different from each other?
Conservative	2400 SEK	1300 SEK	Yes
standard	4700 SEK	3900 SEK	No

The authors repeat the calculations for different subsamples:

- (a) by including all respondents, even those with missing values for the covariates, which they do by fitting a logit (ordered logit) where the only regressor is the bid. The point estimates of mean WTP are similar to those shown in the table above, but both sets of estimates are statistically different from one another.
- (b) By using only the responses where the respondents recognized that there would be no effects on the environment. The results are the same as in (a).

Implied VSL

To compute VSL, the authors first compute the risk reduction implied by the questionnaire: 300 (Half of the 600 annual fatalities)/3,700,000 (the number of households in Sweden, assuming that everyone gets the same risk reduction). This gives 8.1 in 100,000 annual.

On dividing mean WTP by this risk reduction, one gets VSL values ranging from \$4.5 million to \$8.9 million (private risk reduction) and \$2.6 million to \$7.4 million (public program).

Interpretation of the results. Altruistic considerations would suggest that WTP for a public program should be higher than that for a private risk reduction of equal magnitude. The authors argue that whether or not this is true depends on the nature of the altruism. Here, they argue that people facing the public program scenario might have underreported their own WTP for fear that, if others were made to pay the former respondent's WTP amounts, their utility would have been lower. In other words, respondents reacting in this way would have pure, rather than paternalistic, altruism.

Limitations of the Study

- * Survey was done over the telephone, precluding the use of visual aids to explain risks and risk reductions
- * poor choice of econometric model for computing mean WTP
- * authors tried to control for the respondent's subjective baseline risk, but it is possible that whether or not the respondent thought he was at higher, lower, or the same risk as the average driver is endogenous with WTP.
- * no attempt to identify what kind of respondent believes that the policy has effects on the environment as well as on traffic.
- * respondents were told about the total number of fatalities every year in traffic accidents, but were not told about the size of the population in Sweden, so it is unclear that they grasped what the risk was.
- *no attempt to see if respondent accepted that a 50% risk reduction is possible.

Summary form 5

Author(s)	Lanoie, Paul, Carmen Pedro, and Robert Latour
Year of publication	1995
Title	"The Value of A Statistical Life: A Comparison of Two Approaches"
Journal	Journal of Risk and Uncertainty, 10, 236-257.
Valuation method	contingent valuation and compensating wage study Within the same survey questionnaire
Type of risk valued	risk of dying in a workplace accident over one year
Magnitude of the risk	subjective baseline risk is identified by the respondent on a ladder with 10 steps, and ranges from 0 to 8.64 in 10,000; objective risk figures are available from the Quebec Compensation Board, vary by occupation, were the number of deaths per 10,000 workers averaged over Jan 1, 1981 to May 31, 1985. The average in this sample is 1.261 in 10,000.
Magnitude of the risk reduction	in the CV study, one step down the ladder. Note that the ladder identifies the occupation that is represented at each step of the ladder, but not the actual risk. Only after the WTP and WTA questions, the respondent is told that firefighters (a category shown on step 9 on the ladder, one of the occupations with the highest risks) have a risk of dying of 5.8 per 10,000 per year, and that an office worker has a risk of 0.057 in 10,000, and then he is asked what he thinks his or her risk is.
Population	Employees of firms in the Montreal area with 100+ employees. Firms were in the transportation, business and manufacturing industries.
Sampling frame	(a) researchers formed the universe of firms in the Montreal area with 100+ employees. (b) they randomly selected 13 of these firms, wishing to interview about 15 employees in each such firm, for a total of about 200 interviews.

Final sample size: n=191

Later in the paper, however, it is reported that there were a total of 16 firms. It is also mentioned that in some firms employees were sent the questionnaire, which suggests there may have been a mix of sampling/administration modes.

The article claims that the sample was representative of the general population of the Montreal area for sex, age, education and marital status.

Survey method in person.
At cooperating firms, notices were posted announcing that the study would be done at specified times. One interviewer was in the workplace lunchroom at the specified times,

randomly contacting employees and asking them to participate in the study. The interviews were conducted in separate, quiet areas.

The questionnaire was available in both English and French. The authors report the response rate to be 69%.¹

When Not mentioned in the articles. The wage data refer to 1990.

elicitation method in the CV portion of the questionnaire, open-ended.

subjective or objective

baseline risks? For workplace risks, in the CV component of the study: Subjective risks. People are asked to pinpoint on a 10-step ladder which step corresponds to their own job risks. Objective risks are available to the researchers and used in the econometric analysis, but they are never shown to the respondents.

For the risk of dying in an auto accident, in the CV component of the study: objective risks. Respondents were asked to report WTP (WTA) for a change in risk from 4 to 2 per 10,000 (2 to 4 per 10,000).

Commodity being valued (a) workplace risks, using a compensating wage study. (b) WTP for reducing risks by one step on the ladder relative to the current risks. (c) WTA compensation to accept an increase by one step on the ladder. (d) WTP for a reduction in the risk of dying in a car accident from 4 to 2 in 10000. (e) WTA for an increase from 2 to 4 per 10,000 in the risk of dying in car accident.

Is the questionnaire reported in the article? No, but the WTP/WTA questions are.

Do we have questionnaire Available to us? Yes.

Risk Communication Step ladder, with risks being represented as follows:

(high risks)	10	dynamiter in a mine
	9	firefighter
	8	metal worker (iron, steel, etc.)
	7	worker in production of chemical products
	6	truckdriver
	5	lumberjack
	4	electrician

¹ It is not entirely clear how the response rate was calculated, due to the possibility of different methods of administration of the questionnaire. Presumably, this should be equal to (Number of completed questionnaires or interviews)/(Number of persons contacted and asked to participate + number of persons who were sent the questionnaire).

	3	driver/salesman
	2	teller and cashier
(low risks)	1	secretary

Experimental Design n/a. No split samples.

Bid Design n/a

Statistical Model(s) The purpose of the paper is to (i) compare VSL estimated in a contingent valuation (both WTP and WTA) with the VSL from a compensating wage study on the same sample.

VSL from the wage-risk study is estimated using a regression model (see below). VSL from the contingent valuation survey is reported directly in table 4 of the paper for the entire sample, and is based presumably on computing the VSL for each individual (his or her WTP or WTA, divided by the risk of the risk change implied by going down or up the risk ladder by one step) and then averaging over the sample (or over certain subsamples).

VSL from the Contingent Valuation questions of the questionnaire, Lanoie et al. study. All figures in million 1986 Can \$.

	All sample	Manual workers	Unionized manual workers
WTP car safety	1.570	1.466	1.506
WTA car safety	2.809	2.618	2.073
WTA job safety	26.191	39.222	31.472
WTP job safety	22.968	24.908	27.314
WTP job safety*	24.152	--	--

* based on those respondents who pinpointed the lowest risk on the ladder. In the WTP question, these respondents were asked to imagine that they were a step higher.

The table shows that VSL in the auto accident context is stable across subsamples, and is, as expected, higher when measured using WTA than when measured using WTP. The latter point is true both in the auto and the job accident contexts.

VSL based on WTP for job safety (which is judged more reliable) ranges from Can \$ 22 to \$27 million, and is thus more variable across groups than VSL in the auto accident context, but less variable than VSL for job safety based on WTA compensation measures.

Dropping three workers whose WTP for going one step down the ladder is 1/3 of their pre-tax income reduces VSL to Can \$ 15 million.

Compensating wage regression

Dependent variable log weekly wages before tax

Regressors risk variables: fatal risk rate per 10,000 (DEATH);² risk of non-fatal injuries involving at least one day of absence from work (per 10,000) (RISK); SEVERITY (average number of work days lost per compensated accident);³

Occupational attributes: physical exertion, cold, humidity, heat, noise, atmosphere (fumes, odor, dust, etc.). All of these are self-reported and are indices on a scale from 1 to 9.

Individual characteristics: log hours worked, union status (D⁴), age, age squared, experience, supervisor (D), married (D), gainfully employed spouse (D), dependents, gender (D), manual (D), two education dummies (HIGHELM and COLLEGE), three industry dummies (transportation sector, business and other, and manufacturing industry).

Results Compensating wage regressions are attempted for the entire sample (n=162), for manual workers only (n=68), for unionized manual workers (n=63).

In general, the coefficient on the DEATH variable is positive but insignificant for the entire sample, whether DEATH is the objective fatality rate or subjective risk. Focusing on manual workers results in stronger coefficients on the DEATH variable, however measured, but the coefficient is still statistically insignificant. When subjective risks are used and attention is restricted to the unionized manual workers, the coefficient on the DEATH rate thus measured is positive, strongly significant, and robust across different specifications of the regression model. The coefficient ranges from 0.048 to 0.053, and the t statistics range from 2.78 to 3.16.

Implied VSL can only be calculated for the sample of unionized manual workers. The paper reports that VSL ranges from Can \$17.3 to \$19.2 million, which is high relative to previous Canadian studies.

VSL Comparison across CV and wage-risk study This the focus of the paper. Comparison can only be done for the sample of unionized manual workers. As stated, VSL is Can \$ 22 to 27 million from the CV component of the study, and Can \$17.3 to \$19.2 million from the compensating wage study.

The latter figures fall within the 95% confidence interval around the former, suggesting that the alternative estimates of VSL are not statistically different.

However, the authors also use a bootstrap approach, which shows that VSL is much more unstable. The approach identifies 12 persons that are classified as risk-averse, in the sense that they would be willing to pay more for a risk reduction than is implied by their compensating wage equation. Presumably these people inflate VSL relative to the

² In alternative runs, the authors included either the objective or subjective workplace risks. The subjective workplace risks are those identified by the respondents on the risk ladder.

³ The authors point out that Viscusi (1993) emphasizes the importance of including (WC×non-fatal risk rate) in the right-hand side of the econometric model, where WC is worker's compensation. However, in this sample WC is about 15% of the wages for virtually all workers, implying insufficient variation across the sample to use this variable as a regressor. This variable is, therefore, omitted.

⁴ D = dummy variable.

remainder of the sample. For example, their weekly wages average Can \$778.50 but their WTP for reducing risk by one step is Can \$106.00, whereas averages wages and WTP for the sample of 63 unionized manual workers are Can \$58.00 and 844.70, respectively.

Positive Aspects and limitations of the Study

- In conducting this study, which is based on the Gegax et al (1988) and Gerking et al. (1987) questionnaire, Lanoie et al. recognize that Gegax et al. and Gerking et al.'s risk ladder asked respondents to consider workplace risks ranging from 1 in 4000 to 10 in 4000, but the actual US fatality rate of 1 in 10000 was well outside of this range. This resulted in overstating risks, and hence biasing VSL downwards. Their risk ladder is designed very carefully.
- The authors discuss the theoretical reasons why VSL could differ when measured from the compensating wage and the CV contexts.
- Excellent discussions of the reasons why these VSL figures are different from others in Canada and in the literature are provided. The authors are also well aware of the large difference between VSL in the auto and job accident context, and offer reasons for such a difference.
- The authors discuss two key concepts against which they compare the results of their study: reliability and validity. Reliability refers to the closeness/difference of VSL measured using two alternative constructs, such as WTP and WTA. Reliability is examined by looking at the correlation between WTP and WTA for the same phenomenon. Validity refers to regression context but also to the fact that we would expect WTP and WTA for the auto risks to be closer with one another than with either WTP or WTA for job risks.

They find that the cross correlation between WTP and WTA measures for auto and job risks is virtually zero. By contrast, the correlation between WTP and WTA for the auto accident risks is 0.478, and the coefficient of correlation between WTP and WTA for workplace risk reductions is 0.777 (individuals who chose the lowest step on the risk ladder) to 0.827 (all other individuals).

- Despite the interest in correlation coefficient, the paper does not attempt to account for possible correlation within the same individual for WTP from the CV questions and wage rates. No regressions for WTP are reported, and there is no attempt to model the baseline risks as endogenous with either WTP from the CV question or the wage rate.

Summary form 6

Author(s)	James K. Hammitt and John D. Graham
Year of publication	1999
Title	“Willingness to Pay for Health Protection: Inadequate Sensitivity to Probability?”
Journal details	Journal of Risk and Uncertainty, FILL, 33-62.
Valuation method	(i) review of 25 previous contingent valuation studies; (ii) replication of CV study by Johannesson et al. (1997); (iii) two new contingent valuation studies
Type of risk valued	(i) previous studies: various types of risk (ii) replication of Johannesson et al: own risk of dying for any cause in one year (iii) original studies: risk of dying in an auto accident, food safety
Magnitude of the risk	(i) previous studies: ranges from 1 in 20 to 1 in 100,000 (ii) replication of Johannesson et al: in split samples, X in 10,000 and 10X in 100,000 (iii) original surveys: 20 and 25 in 100,000 (auto accident), 1 in 37,000 or 1 in 370,000 (outdoor eating establishment in developing country) v. 1 in 100 million (indoor eating establishment in developing country)
Magnitude of the risk reduction	(i) previous studies: varies (ii) replication of Johannesson et al.: 2 in 10,000 or 2 in 100,000 (split samples), with bids divided by 10 to keep them corresponding to the same VSL (iii) original studies: auto accident: 15 in 100,000 or 10 in 100,000, food safety: respondent must choose between the indoor and the outdoor eating establishment, where the cost of the meal is different
Population	(i) previous studies: varies (ii) replication of Johannesson et al.: US residents ages 18-65 (iii) original studies: US residents, ages 18 to 65
Sampling frame	(i) Lit review: varies (ii) replication of Johannesson et al.: Random digit dialing, with quotas to ensure geographical representativeness

	(iii) original studies: same as (ii)
survey method	(i) previous studies: varies (ii) replication of Johannesson et al.: telephone (iii) original CVs: telephone
Elicitation method	(i) previous studies: open ended/payment card, dichotomous choice (ii) replication of JOhannesson et al.: Single bounded dichotomous choice (iii) original studies: survey 1, auto accident, double bounded dichotomous choice; survey 2, auto accident, follow-up question to get closer to the indifferent risk; ⁵ survey 2, foodborne safety, 1 ½ bound dichotomous choice
Subjective or objective baseline risks?	(i) literature review: mostly objective risks (ii) replication of Johannesson et al.: objective (iii) original studies: objective, although in survey 2 about auto risks, the questionnaire attempts to elicit indifference risks, which, of course, vary over the respondents.
Commodity being valued	(i) literature review: mortality risk reductions in various Contexts, including auto accidents and food safety (ii) replication of Johannesson et al.: reduction in own risk of dying for various causes, where the reduction is delivered by medical intervention (iii) survey 1: air bags of two different types; survey 2, auto accident: airbags, survey 2 food safety, different eating establishments
Is the questionnaire reported in the article?	(i) literature review: no (ii) replication of Johannesson et al.: No, but original questionnaire is available to us; the Hammitt and Graham article spells out the WTP question and the bids (iii) original studies: no, but the valuation questions are usually spelled out

Do we have questionnaire

⁵ If the respondent was willing to pay the proposed bid for the initial risk reduction, he was asked whether he would pay the bid even if the risk was smaller. If the respondent declined to pay the initial bid, he was asked whether he would pay the bid for a larger risk reduction. Respondents who switch response (yes-no and no-yes) imply that the indifference risk is between the first and the second risk reductions stated to them in the survey. Respondent who answered yes-yes are construed to hold indifferent risk values that are smaller than the smaller of the two risk reductions stated to them. Respondents who answered no-no are construed to have indifference risks that are greater than the larger of the two risk reductions stated to them.

Available to us?	No, but we do have the original Johannesson et al. survey Questionnaire
Experimental Design	<p>(i) lit review: varies</p> <p>(ii) replication of Johannesson et al.: split sample, with one subsample being given risks expressed in X per 10,000, and risk reductions of 2 in 10,000. The other subsample was given risks expressed in 10X in 100,000, and the risk reduction was 2 in 100,000, but the bids were 1/10 of the corresponding bids for the other group, so as to keep the implied VSL the same.</p> <p>(iii) original surveys. Survey 1. respondents are asked a probability quiz question to see if they understand changes in the denominators the risks are expressed in. Split sample, with one subsample being exposed to analogies, and the other not being exposed to analogies. Analogies were intended to help people grasp the magnitude of risks, and are in terms of distance (inches in a mile), population (cities, empty seats in a full stadium), time (minutes in a year), games of chance (coin flipping). People exposed to the analogies were first asked to rate them in terms of helpfulness understanding risks; questions about risks were re-stated using the analogies, and then people were asked again if they found the analogies helpful.</p> <p>Survey 2, the only experimental design is different bids.</p>
Bid Design	see above
Statistical model used To estimate mean or Median WTP	<p>(i) lit review: varies</p> <p>(ii) replication of Johannesson et al: single bounded logit model</p> <p>(iii) original surveys: double or 1 ½ bounded</p>
WTP Regressions?	<p>(i) lit review: varies</p> <p>(ii) replication of Johannesson et al study: same logit model as original (regressors: bid, age, age sq., education, income, plus a dummy for the high-bid subsample)</p> <p>(iii) original surveys: survey 1: separate regressions for persons who answered the probability quiz correctly and incorrectly, analogies exposure and no analogy exposure. Survey 2: separate regressions for persons that are and are not confident in their responses to the payment questions.</p>
Regressors in WTP	

Regression

see above

Results

the goal of the research is to assess (i) sensitivity of WTP to the size of the risk reduction, and (ii) strict proportionality of WTP with respect to risk reduction, using both internal and external tests.

(i) lit review. Scope is more easily satisfied in internal than external tests, but there is a sizeable portion of the sample whose WTP does not change with risk reduction.

Proportionality is violated in internal tests. External tests see little responsiveness to the size of the risk reduction and generally fail the proportionality tests.

(ii) replication of Johannesson et al. and original studies. Little responsiveness to risk reduction and no proportionality, despite the use of analogies etc. Things improve slightly for persons that are more confident about their responses to the payment questions.

Implied VSL

varies, but in the replication and in the original studies is Generally within the accepted range

Limitations:

the authors recognize that part of the problem could be the reliance on telephone surveys. It is possible that analogies and other devices intended to promote understanding of the magnitude of risk and risk reduction will perform differently if paired with visual aids

Other :

the study was conducted to investigate scope and proportionality. It nicely discusses three reasons why in the past there has been little responsiveness of WTP to scope, and failure of proportionality. The first reason is that people do not grasp small risks and risk changes; the second that they value perceived risks, and not the objective risks stated to them in the survey. In this case WTP may well vary with perceived risks, but the latter are not explicitly observed by the researchers. Finally, it is possible that people use models other than the expected utility models, but even so WTP should be approx proportional to the risk changes, at least for small risks.

The authors also discuss how WTP should increase with baseline risks, but that this effect should be negligible when

the baseline risks are very small, as is the case with most mortality risk reductions studies.

When respondents were asked to state how confident they felt about their responses to the payment questions in original survey 1, 70% stated that they felt very confident, 26% somewhat confident, 3% not too confident, and 1% not at all confident.

Summary form 7

Author(s)	Corso, Phaedra, James K. Hammitt and John D. Graham
Year of publication	2001
Title	“Valuing Mortality Risk Reductions: Using Visual aids to Improve the Validity of Contingent Valuation”
Journal details	Journal of Risk and Uncertainty, 23(2), 165-184.
Valuation method	contingent valuation
Type of risk valued	risk of death in auto accidents
Magnitude of the baseline Risk	2.5 or 2.0 in 10000 in split samples
Magnitude of the risk reduction	1.0 or 0.5 in 10000, directly corresponding to the baseline risks of 2.5 and 2.0, respectively. The final risk, after the risk reduction, is 1.5 in 10000 for both subsamples. Risks and risk reductions are per year.
Population	residents of the US of ages 18 and older
Sampling frame	residents of the US of ages 18 and older, recruited through random digit dialing
Survey method	phone-mail-phone: combination of phone contact, mailing of survey materials, and phone interview. Once participation was secured during the initial phone call, respondents were mailed the survey materials plus \$5 compensation. Responses to all questions were collected during the final interview.
Elicitation method	dichotomous choice with dichotomous choice follow-up
Subjective or objective risks?	Respondents were told about objective baseline risks, and asked to value an objective risk reduction. However, they were also asked whether they thought their own risks were higher than the average, the same as the average, or lower than the average (qualitative information only).
Commodity being valued	Reduction in the risk of dying in a car accident. The risk

reduction is delivered by a side-impact airbag, and is thus a private risk reduction.

Payment vehicle

increase in the auto insurance annual rate for the next 5 years.

Is the questionnaire reported in the article?

No, but two of the three types of visual aids used in the survey (the linear and the logarithmic risk ladder) are reported in the Appendix

Do we have questionnaire Available to us?

Yes, but not the survey packet, which contains the visual aids. Two visual aids are reported in the Appendix of the paper, but not the visual aid based on the dots.

Experimental Design

two experimental treatments: (i) baseline risk and Accompanying risk reduction (two groups: 2.5 in 10000 → 1.5 in 10000, 2.0 in 10000 → 1.0 in 10000), and (ii) visual aid types (4 levels: linear scale, logarithmic scale, dots, and no visual aids), for a total of 8 independent samples. Within each of these, random assignment of respondent to one of the bid levels described below.

Bid Design

Four bid sets total:

Bids in US dollars	Initial bid	If yes	If no
I	50	100	25
II	100	200	50
III	200	400	100
IV*	400	800	200

* This bid set was added during the course of the study, as the first three bid sets appeared to be low.

The bids imply VSL values ranging from \$250,000 to \$16 million.

Sample size

N=1104 total, with 277 in the linear scale group, 288 in the Logarithmic scale group, 264 in the dots group, and 275 in The no aids group.

Statistical model used To estimate mean or Median WTP

double-bounded model of WTP, WTP is a lognormal. Median WTP figures are reported in the paper.

WTP Regressions?

Yes

Regressors in WTP Regression

dummy for the size of the risk change, age, male, income, dummy if airbags are perceived by the respondent as effective, perceived risk dummy, perceived risk dummy \times dummy if airbags are thought effective. Regressions are separate for the subsamples with different type of visual used, but pool people with different risks and risk reductions.

Results

the purpose of the paper is two-fold. It wishes to
 (i) investigate whether failure to understand probabilities is one reason why sometimes WTP for mortality risk reductions sometimes fails to increase with the size of the risk reduction, and/or fails to be proportional to the size of the risk reduction, and
 (ii) see if this problem can be mitigated or avoided by using visuals that aid the respondent in grasping the magnitude of the risk and risk changes.

The paper conducts two types of scope tests. The weak scope test is passed if WTP increases significantly with the size of the risk reductions. The strong scope test is passed if WTP is strictly proportional to the size of the risk reduction.

The paper finds that only two of the types of visuals (the Logarithmic risk scale and the use of dots) result in WTP That exhibits both the weak and the strong scope effect.

In the group with the linear risk scale, the coefficient on the dummy for larger risk reduction is positive and significant at the 10% level, implying that WTP barely passes the weak scope test, but not the proportionality test, and in the group with no visual aid, the coefficient on the risk dummy is positive but insignificant.

Relatively few other regressors are found to be significant in the WTP regression. Income is significant only in the regression for the no visual and the dots group. The implied income elasticities of WTP are 0.4704 (no visuals) and 0.4048 (dots).

Another significant regressor is whether side impact Airbags are perceived as effective in reducing risks.

On pooling the data from all groups and using dummies for the type of visual aid used, the authors find that the dots depiction works best, while the others are not different than using no visual aids at all.

The main conclusion is that the dots work well.

Implied VSL

Vary by visual aid group and by the size of the risk and risk reduction. See table below.

VSL in million \$				
	No aid	Linear scale	Log scale	Dots
1 in 10,000 risk reduction	2.530	3.620	3.370	2.900
0.5 in 10,000 risk reduction	4.700	5.860	4.180	3.180
WTP ratio*	1.08	1.24	1.61 ^{a, b}	1.82 ^{a, b}

* based on median WTP. If WTP were truly proportional to the size of the risk reduction, this ratio would be 2.

^a = WTP increases significantly with the size of the risk reduction (weak scope test)

^b = WTP is proportional to the size of the risk reduction (= WTP ratio is not statistically different from 2) (strong scope test)

Self-selection into the sample

Comparison with the population of the US indicates that the sample has a slighter lower income than the typical US household (median household income in the sample: \$46,000; median household income in the US in 1997: \$49,000) and somewhat more highly educated.

Selection into the sample due to interest in the topic is judged as not important, because people were not told what the survey was about before securing their participation.

The four subsamples that were given different visual aids are similar in terms of socio-demographics, belief in airbags, and rating of own risks relative to the stated baseline, suggesting that any difference in WTP are solely due to the visual aid treatment.

Debriefing questions

respondents were asked: (i) if they had frontal impact airbags, (ii) if they thought airbags were effective in preventing fatalities, and (iii) whether they thought their

own risk of dying in a car accident was higher, the same as, or lower than that stated to them in the questionnaire. After the WTP questions, respondents were asked how confident they felt about their responses to the WTP questions.

Robustness checks

(i) The authors tried Single bounded models, finding that WTP was higher than in the double-bounded models, and that it increased more than proportionally to the size of the risk change.

(ii) Weibull WTP models were tried, with similar results as those reported in the paper. (This is unsurprising: the paper reports median WTP, which is generally very similar across weibull and lognormal models. In addition, the typical weibull regression model gives regression coefficients that are virtually identical to those of log normal regressions.)

(iii) people were separated into groups based on their degree of confidence when answering WTP questions, but this made no change.

Limitations of the study

(i) Considering that the authors use double-bounded models, the sample sizes are really too small to afford separate samples. This might explain why the group with no visuals and that with the linear scale did not exhibit (or only exhibited very weak) scope effects.

(ii) the authors did not attempt to explore what kind of respondents reports that their risks are higher or lower than the risks stated to them, and whether these beliefs are endogenous with WTP.

(iii) the dots visuals are not available, so it is not possible to judge their quality. However, based on examining the linear and log scale reported in the Appendix of the paper, which very “busy,” they are probably correct in concluding that the simpler, more abstract dots managed to get respondents more focused on the risks and less distracted by other factors.

Summary form 8

Author(s)	Miller, Ted, and Jagadish Guria
Year of publication	1991
Title	“The Value of a Statistical Life in New Zealand: Market Research on Road Safety”
Journal details	Report to the New Zealand Ministry of Transport
Valuation method	contingent valuation
Type of risk valued	risk of death in auto accident/road safety
Magnitude of the risk	X in 10000 ⁶
Magnitude of the risk reduction	(a) in the question about WTP for safer toll road, the risk reduction is 3 in 10000 (b) in the question about choice of neighborhood to live, the risk reduction is 200 to 1000 in 10,000
population	New Zealand households
Sampling frame	stratified random sample of New Zealand households.
Sample size	N=655. After persons who failed arithmetic questions are Excluded from the sample, N=629
Survey method	in person. The auto safety survey was mounted on a pre-existing travel mode survey. Interviewers were sent to the homes of persons who had previously participated in the travel mode survey. The travel mode survey surveyed all family members over the age of 5.
Date of the survey	December 1989
elicitation method	open ended
subjective or objective baseline risks?	presumably objective. In the questions about driving Behavior in bad weather, respondents were asked to report
	the subjective risk reduction incurred by driving more

⁶ Not explicitly reported. It appears that in one valuation question—subsequently judged to be poorly phrased, and dropped from the analyses—the baseline risk would have been in order of 1 in 10,000.

slowly, relative to the risk for the average driver.

commodity being valued	<p>> WTP for five commodities:</p> <ul style="list-style-type: none"> • Safer toll road (private risk reduction, just for self) • Driving safety course (private risk reduction, self and family) • Car safety features (private risk reduction, self and family) (airbags, side impact) • Living in a safer neighborhood (private risk reduction, self and family) • Roadway and pedestrian safety via taxes (public risk reduction, self, family, and other people) <p>> Tradeoff between severe injuries and death, and between severe head injuries and death</p> <p>> Driving behavior to observe time sacrificed to reduce risks when driving in bad weather</p>
Is the questionnaire reported in the article?	No. They say it is in Appendix 1, but there is no such Appendix in this paper and in the accompanying report on the VSL for family members ⁷
Do we have questionnaire Available to us?	No
Experimental Design	No mention where the risk reduction is varied across Respondents or other experimental treatments are Implemented. Risk reduction is varied within the Respondent in different questions.
Bid Design	not applicable (not a dichotomous choice questionnaire). (An initial bid is used in a few of the elicitation questions For some of the risk reductions)
Statistical model used To estimate mean or Median WTP	sample average
WTP Regressions?	Yes, but they are not reported
Regressors in WTP	gender, age, race, income, urban v rural, and family size. The authors produce estimates of WTP by gender, age

⁷ Miller, Ted, and Jadish Guria (1991), "Valuing Family Members' Statistical Lives," Report to the New Zealand Ministry of Transport.

group (the elderly have a lower VSL), and report that WTP increases with income (1 or 2 percent for every \$1000 of household income) and decreases in family size.

The authors also collect information about behavior that Could be related with risk aversion, and report that those Perceive their risks as large are willing to pay less for risk Reductions.

The responses to the speed choice question were affected by driving experience, and by previous accident experience.

Results

VSL based on the responses to the safer toll road, safer car, And safer neighborhood questions Estimated to be 1.9 million NZ dollars, with 95% confidence interval \$1.4 to \$2.3 million.

VSL based on pooled data \$1.9 million, with 95% c.i. \$1.7 to \$2.2 million.

VSL based on speed choice behavior \$1.9 million, with 95% c.i. \$1.4 to \$1.9 million.

Implied VSL

VSL ranges between NZ \$1.4 million and \$2.3 million, Depending on the risk reduction being valued. The Composite (pooled data) estimate of VSL is NZ \$1.9 Million (all figures in 1989 NZ dollars). These estimated Values are judged to compare well, and be on the low side Of the range of, VSL from other countries and contexts.

Summary of VSL. All figures in 1989 NZ dollars (at the time of the study, 1 US dollar = 1.60 NZ dollar).

How valued	VSL*	Sample size used
Average WTP	1.893	
Safer toll road	2.009	308
Road safety course	1.437	296
Safer car**	1.871	226
Safer neighborhood	1.871	500
Roadway and pedestrian safety taxes	2.297	108
Speed choice question	1.938	

* VSL figures refer to all household members; ** = used respondent-reported estimate of how long they would hold on to the car, and applied various discount rates (0 to 10%).

Data cleaning:

the responses to the payment questions were subjected to a Number of data cleaning criteria:

* if person reported zero WTP for safety course, but later stated he was WTP something for the car safety features, the zero response was treated as a protest and discarded.

* if value of safety for the rest of the family, which was derived as difference between total WTP and WTP for own risk reduction, is negative, observation is discarded

* if value for other members of the family is > 4 times value for own risk reduction, observation is discarded

* excessively large bids discarded

	missing	Discarded		Kept	
		Positive WTP	Zero WTP	Positive WTP	Zero WTP
Toll road	5	215	111	291	17
Training course		10	226	97	268
Car safety features	96	230	42	230	23
Safer neighborhood	87	11	31	487	13
Taxes for road safety	225	150	123	102	6

Observations:

* the authors recognize that the toll question tended to elicit WTP “by coin” (50 cents or 1 dollar), and they strove to Convert the cost on an annual basis; the question was Judged to have worked well.

* the safety course question did not work well. People did not find the course effective, or would not have taken it for other reasons.

* the car safety feature question was judged to have worked well, with most people capable of providing an estimate of the lifetime of the car. Because benefits are spread over the

lifetime of the car, discount rate was used, with the authors experimenting with 0 to 10% discount rates. The actual discount rate used did not make a difference, but using discount of 0% introduced some inconsistencies between the responses to different risk questions for some people.

* the neighborhood safety question worked well, but required disentangling the tradeoff between injuries and deaths, and head injuries and deaths. On average, 30 severe injuries were judged by the respondents to be equivalent to one death, and 45% of the respondents found that the head injury (with person affected unable to take care of himself, move, speak, etc) was worse than death.

* driving behavior question was found to work well, with people giving responses consistent with the VSL values implied by the responses to the CV questions. People were asked to identify a road that they frequently used, and say whether they would drive more slowly in windy and rainstorm conditions. They were also to estimate the difference in risk between driving at the usual (dry weather) speed in bad weather, and driving more slowly. One death was judged to be equivalent to 253,000 hours (average) (median in 189,539 hours), which can be valued at the average hourly rate of \$13.37 to produce VSL.

Other:

one of the goals of the study was to elicit how much one is prepared to pay for one's own risk reduction, and how much other members of the family are willing to pay for this person's safety.

The study elicited WTP for risk reductions that affected the entire household, then multiplied WTP by the number of people in the household, then subtracted value of own risk reduction, and finally divided by the number of people in the family.

To compute a value for the family, they recommend just using two adults, ignoring children.

Limitations of the study

use of open ended questions; no attempt to control for correlation between questions, and/or sequencing effects. Also, many discarded observations because the consistency checks were done ex post by the researchers, but were not imposed on the respondents during the course of the survey.

Summary form 9

Author(s)	Viscusi, W. Kip, Wesley A. Magat, and Joel Huber
Year of publication	1991
Title	“Pricing Environmental Health Risks: Survey Assessments of Risk-risk and Risk-dollar Tradeoffs for Chronic Bronchitis”
Journal details	Journal of Environmental Economics and Management, 21, 32-51
Valuation method	<p>variant of conjoint choice survey. Respondents were asked To indicate which of two locations they would live. The Two locations were described by risk in terms of (a) risk of In an auto accident, (b) risk of chronic bronchitis, and (c) Cost.</p> <p>The attributes were altered across alternatives A and B In an interactive way to get to the indifference points. The Following were estimated: (a) treadeoff rates between the Risk of chronic bronchitis and the risk of dying in an auto Accident; (b) the risk-dollar tradeoff referring to the risk of Dying in an auto accident, and (c) the risk-dollar tradeoff For the risk of chronic bronchitis.</p>
Date of the survey	not reported.
Type of risk valued	risk of death in auto accidents; risk of contracting chronic bronchitis
Magnitude of the risk	X in a population of 100,000
Magnitude of the risk reduction	X in 100,000
Population	persons visiting a shopping mall in Greensboro, North Carolina
Sampling frame	shoppers were intercepted at the shopping mall. No details Are provided about how exactly these persons were Intercepted (by stopping every other fifth person passing by, etc). N= 389.

survey method	self-administered computer survey
elicitation method	point values for the risk-dollar tradeoffs and for the risk risk tradeoffs. These are attained through a sequence of discrete choice questions. After observing which alternative is picked, the next question alters one attribute, until indifference is reached
subjective or objective risks?	objective. However, (i) respondents were told that the risks were specific for them and had been calculated on the basis of their behaviors like smoking, miles driven, etc. even though this was not true and the same number was presented to everyone. Also, (ii) the authors worry that some respondents may have replaced the objective risks of auto accident fatality with their own risks, based on driving skills and miles driven.
commodity being valued	risks are presented as the choice between location A and B
is the questionnaire reported in the article?	No
Do we have questionnaire Available to us?	No
Experimental Design	two versions of the questionnaire, presented to split Samples. Version I obtains (a) tradeoff rates between Chronic Bronchitis and auto death risks and (b) risk-dollar tradeoffs for chronic bronchitis. Version II obtains (a) same as for version I, and (c) risk-dollar tradeoffs for auto risks.
Bid Design	not applicable. However, the risks used in the initial questions are not reported in the paper.
Statistical model used To estimate mean or Median WTP	paper presents mean and median tradeoff rates between risks, and risks v. dollars; percentiles of the distributions of tradeoff rates are also presented
WTP Regressions?	No. Paper reports that regressions were attempted to relate The tradeoff rates to individual characteristics but that no meaningful relationships were found.
Regressors in WTP Equations	not applicable

Results

mean tradeoff rate between the risk of contracting chronic bronchitis and the risk of dying in an auto accident indicate that a change in the risk of the former is viewed as equivalent to a 0.70 as great a change in auto risk. This means that chronic bronchitis is seen as a little less serious than the risk of dying in an auto accident. (The median tradeoff rate is about $\frac{1}{2}$ as much.)

The mean risk-dollar tradeoff for chronic bronchitis is 8.83 dollars for a 1 in 100,000 risk reduction, which implies a VSL of \$883,000. Using median tradeoff rate, instead of mean, results in VSL of \$457,000.

The mean risk-dollar tradeoff for auto accident is 81.84 dollar for a 1 in 100,000 risk reduction, which implies a VSL of \$8,184,000. Based on the median tradeoff, VSL is 2,286,000.

Implied VSL

see above

Limitations of the study.

Creative approach for estimating the value of risk Reductions. However, it is difficult to extrapolate results to The population, because the sample is presumably not Representative, there is no statistical relationship with Individual characteristics so that predictions can be made For another population, and the sampling scheme is not reported.

Other:

the authors implemented a series of consistency checks, Excluding from the usable sample those respondents who

- (i) never changed the choice (e.g., always chose A)
- (ii) only changed to indifference
- (iii) reversed response
- (iv) indicated a boundary result, or
- (v) were always indifferent.

This resulted in dropping almost two thirds of the responses.

Summary form 10

Author(s)	Viscusi, W. Kip and Wesley A. Magat
Year of publication	1991
Title	“Policy Analysis and Benefit Valuation for Environmental Regulation”
Journal details	Draft Report to the US Environmental Protection Agency, Cooperative Agreement CR 814388424, Durham, NC, January
Valuation method	variant of conjoint analysis questions
Type of risk valued	<p>risks of three diseases potentially associated with environmental exposures (peripheral neuropathy [a nerve Disease]; curable lymphoma (chance of dying 10%) and terminal lymphoma (chance of dying 100%). Risks of dying in an auto accident.</p> <p>People are asked to indicate which location they would prefer to live in, A or B, which differ for risks and cost of living. Indifference points are elicited.</p> <p>Risk-risk tradeoffs between risk of a disease and risk of auto accident, and risk-dollar tradeoffs.</p>
Magnitude of the risk	X in 1,000,000 for the diseases
Magnitude of the risk reduction	1 in 1,000,000
Population	shopping mall visitors (blue collar shopping mall in Greensboro, NC)
Sampling frame	respondents were intercepted at the shopping mall, but no details are provided about how persons were intercepted
Survey method	self-administered interactive computer surveys
elicitation method	<p>first questions, nine-point scale to indicate strength of preference between A and B, then indifference points are elicited, resulting in tradeoffs rates and point values for dollar amounts</p>

subjective or objective baseline risks? objective. In discussing people with outlier tradeoff rates, the authors point out that some people may have substituted their own subjective beliefs about the risk of dying based on skills, miles driven, etc.

commodity being valued changes in the risks of diseases and car accident deaths associated with moving from one place to the next. Respondents were told that at these locations the risks of these diseases were lower than those experienced in the city where they live now (to avoid alarmistic reactions).

is the questionnaire reported in the article? No—sample initial choice question reported in table 2.

Do we have questionnaire Available to us? No

Experimental Design eight independent samples with various sequences of risk—risk and risk-dollar tradeoffs

Bid Design not applicable. However, the report does not contain any information about the (initial) levels of risks or costs used in the study

Statistical model used To estimate mean or Median WTP mean and median tradeoff rates, plus other descriptive statistics of the distribution of the tradeoff rates

WTP Regressions? No, but correlations were attempted between the mean aversion scores and the tradeoff rates. (Respondents were asked to rate every consequence of a disease on a scale from 1 “least important to avoid” to 9 “most important to avoid.” People generally judged as highly undesirable symptoms that they are relatively little familiarity with, such as bleeding of the joints and skin.)

A person’s mean aversion score for one disease generally correlated well with the tradeoff rate between the risk of that disease and the risk of dying in an auto accident. By contrast, the mean aversion scores did not correlate well at all with the risk-dollar tradeoffs for that disease.

Regressors in WTP Regression N/A

Results curable lymphoma: tradeoff rate with auto accident is such that a 1.6 in 1,000,000 change in risk is judged equivalent to a change in risk of 1 in 1,000,000 in the risk of auto death. The corresponding tradeoff rate is $1/1.6=0.625$, implying that the value of a statistical case of curable lymphoma should be VSL for auto

accident, times 0.625. Using a VSL of 4 million dollars for auto accidents, this means that the value of curable lymphoma is 2.5 million dollars.

Tradeoff rate between terminal lymphoma and auto death is about 1, implying that the corresponding VSL is equal to that in car accident, or \$4 million.

Tradeoff rate between the nerve disease and an auto death is such that a risk change of 2.5 in 1,000,000 in former is judged equivalent to a change of 1 in the risk of dying in a car accident. The corresponding value is thus $1 / 2.5 = 0.4$, or \$1.6 million.

Implied VSL see above

Limitations of the
Study

Other: the paper concludes that the risk-risk tradeoff approach worked well, especially with these relatively little known illnesses. By contrast, the risk-dollar tradeoffs did not work quite so well, appeared to be affected by initial values included in the questions, and several people reported implausibly high values.

Summary form 11

Author(s)	Jonathan Baron
Year of publication	1997
Title	“Confusion of Relative and Absolute Risk in Valuation”
Journal details	Journal of Risk and Uncertainty, 14, 301-309
Valuation method	contingent valuation
Type of risk valued	risk of death for various causes, including diseases and non-diseases causes of death (e.g., firearms, etc.)
Magnitude of the risk	experiment 1: lives saved: 900 in 1000, 900 in 10000, 90 in 100, 90 in 1000; experiment 2: 5% reduction in a given cause of death, 2600 American lives saved
Magnitude of the risk reduction	see above
population	students at the Univ. of Pennsylvania and Philadelphia College of Pharmacy and Science
sampling frame	recruiting of the students not reported in the paper. Participants in the study were paid by the hour.
survey method	written questionnaire
elicitation method	open-ended
subjective or objective baseline risks?	objective, and referred to a population (1000 people who Die of this disease each year).
commodity being valued	treatment that would save a specified number of lives and have to be paid for with extra health insurance above and beyond basic coverage
Is the questionnaire reported in the article?	No (but WTP questions are reported in the article).
Do we have questionnaire Available to us?	No
Experimental Design	experiment 1: n=95, experiment 2: n=29

experiment 1: lives saved: 900 in 1000, 900 in 10000, 90 in 100, 90 in 1000 (total eight questions for each respondent); experiment 2: 5% reduction in a given cause of death, 2600 American lives saved

Bid Design	N/A
Statistical model used To estimate mean or Median WTP	geometric means
WTP Regressions?	Possible for experiment 1 data, but not explicitly mentioned
Regressors in WTP Regression	experiment 1: lives saved, percentage risk reduction, age (presumably, of the persons whose lives are saved)

Results the paper starts from the implicit assumption that WTP should be proportional to the number of lives saved: $WTP = \alpha \times L$, where L is lives saved. $L = N \times R \times \% \text{ risk reduction}$, where N is the population and R is baseline risk.

But the first experiment finds that the percentage risk reduction has further explanatory power for WTP, above and beyond that of L . In addition, WTP grows with L , but not in a proportional fashion. There is a ten-fold increase in the number of lives saved from some questions to the others, but only a two-fold increase in WTP.

The second experiment finds that WTP depends on prevalence, but is not proportional to prevalence (prevalence presumably means baseline risk).

Implied VSL	not computed
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Limitations of the Study	Small sample sizes, use of students rather than general population, use of a context (universal coverage health care which in itself may have been controversial and may have distracted respondents).
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Summary form 12

Author(s)	Johannesson, Magnus, Bengt Jönsson, and Lars Borgquist
Year of publication	1991
Title	Willingness to Pay for Antihypertensive Therapy—Results Of a Swedish Pilot Study
Journal details	Journal of Health Economics, 10, 461-474
Valuation method	contingent valuation
Type of risk valued	risk of death for myocardial infarction and stroke
Magnitude of the risk	<p>subjective baseline risk without treatment over 5 years: Mean (median) 7.5% (5.0%)</p> <p>Subjective risk with treatment over 5 years: Mean (median) 3.2% (3.8%)</p> <p>Subjective risk reduction due to treatment: Mean (median) 4.3% (1.2%)</p>
Magnitude of the risk reduction	see above
population	481 patients on the hypertension register at the primary health care center Atvidaberg. The average age of the patients is 64.
sampling frame	questionnaire were mailed to the entire patient roster. The average age of the sample is about 64, and of the persons in the sample who were asked the risk questions about 59.
survey method	mail
date of the survey	1989
elicitation method	open-ended to one of two split samples, single-bounded dichotomous choice to the other sample
subjective or objective risks?	<p>subjective baseline if the respondent were to go without treatment, subjective risk reduction due to the treatment. Risks expressed over 5 years. All respondents were currently receiving treatment.</p>

commodity being valued antihypertensive treatment (private risk reduction). Respondents were also asked whether they would undertake changes in diet, exercise, etc. if user fees increased, in an effort to find out about substitution patterns with non

is the questionnaire reported in the article? Only the wording of the WTP question (in the Appendix)

Do we have questionnaire Available to us? No

Experimental Design two split sample. Sample 1 received the WTP question in an open-ended format. People were to report max WTP for current treatment of hypertension (high blood pressure, or HBP). Sample 2 received the WTP question in a dichotomous choice format. People were asked whether they would pay a higher fee of X SEK for the current treatment.

The 175 people on the patient register of age 70+ were not asked the risk question.

Bid Design (in the sample that was asked the payment question in the dichotomous choice format) bids range from 100 SEK to 10,000 SEK. Specific bids not reported in the article. Percentage yes/no for each bid not reported in the article.

Return rate 322 returned questionnaire out of 481 (return rate about 67%). Return rate was slightly higher among those persons who received the dichotomous choice questionnaire version (68% return rate v. 65% among those with open-ended questionnaire).

Return rate is 67% among those who were asked the risk question, and 67% among those who were asked the question about substitution, so it does not seem to be influenced by the inclusion of these questions in the questionnaire.

Selection into the sample The researchers had access to the register of patients with hypertension at the hospital, so they knew some basic information about these persons, and were able to compare the individual characteristics of those persons who returned the questionnaires with those of the persons who received the mailings. The likelihood of returning the questionnaire does not depend on age, but does depend on gender. Specifically, the percentage of males is higher among the respondents (49%) than it is among the non-respondents (31%).

Item nonresponse The item nonresponse rate for the WTP question is much higher in the questionnaire version with the open-ended WTP question (59%) than for the discrete choice version (18%). This and other considerations (see “Results” below) led to the conclusion that the open-ended question did not work well.

Statistical model used

To estimate mean or Median WTP logit model of the dichotomous choice responses, with log bid. WTP is the area under the 1-cdf curve. Two limits of integration were used, 10000 SEK and 15000 SEK.

Results are compared with non-parametric procedure by Kristrom, which computes the area under the (1-cdf), based on plotting out the cdf.

WTP Regressions? Yes, logit model for the dichotomous choice responses.

Regressors in WTP Regression log bid, risk reduction, perceived substitution (dummy) with non-medical prevention, age, sex, taxable income. The signs of the respective coefficients are negative, negative, negative, negative, positive. This is the most complete model, but it could only be run with n=61 (older people were not asked the risk question, and there were lots of missing values for other covariates). An alternative specification is reported that drops risk and keeps only log bid and the non-medical substitute dummy (n=135).

Results 1. the open-ended format for the WTP question did not work well. Those respondents who were given this version of the questionnaire had a higher item nonresponse rate, more protest responses, and about one-third of those respondents with usable WTP answers censored their WTP at 350 SEK, the annual cost of antihypertensive treatment, which they were told about in the questionnaire.

2. WTP is as follows (1989 SEK)

	Median WTP	Mean WTP	
		Limit of integration 10000 SEK	Limit of integration 15000 SEK
Logit model	2900	4500	5500
Non-parametric (Kristrom, 1990)	2500	4200	5100

It should be noted that the parametric and non-parametric approach give similar results. The authors also point out that while median WTP is the most desirable welfare measure from the statistical point of view, the appropriate measure to use for cost-benefit analysis purposes is mean WTP.

3. based on the regression results,

$\log \text{WTP} = 7.49 - 0.028 * \text{Substitute} + 0.375 \log \text{risk reduction} + 0.444 \log \text{income} - 0.7 \log \text{age} - 0.18 \text{sex}.$

This implies that WTP is not strictly proportional to the size of the risk reduction, but increases with it. Also note that the income elasticity of WTP is 0.444. The effect of the

substitute is small in this equation, but it is much larger in the more parsimonious equation.

Implied VSL 2500-5000 SEK a year, which (at the mean risk reduction) implies a VSL of 280,000-560,000 SEK.

Limitations of the Study This appears to be a nicely designed and interesting study that EPA might have an interest in, due to its focus to persons at higher risk of certain adverse health effects of air pollution. Possible limitations:

- * the study does not seek to describe the socio-economics of hypertension patients at the clinic with those of the general population. (It does, however, explore possible self-selection into the sample on the part of those who returned the questionnaires).

- * in the econometric model of the WTP responses, the risk reduction is treated as exogenous with WTP, but it is likely to be endogenous with it. Perhaps this is one reason why the p-value of the coefficient on log risk reduction is only 0.16 (another reason might be that the sample size for this regression run is very small). Similar considerations apply to the dummy measuring non-medical prevention substitute activities.

- * a logit model with log bid implies a log logistic distribution of WTP. Depending on the value of the parameters, a log logistic distribution may have infinite mean, so it would be best to avoid using this distributional assumption.

Summary form 13

Author(s)	Johannesson, Magnus, Per-Olov Johansson, Bengt Kristrom and Ulf-G. Gerdtham
Year of publication	1993
Title	“Willingness to Pay for Antihypertensive Therapy—Further Results
Journal details	Journal of Health Economics, 12, 95-108
Valuation method	contingent valuation
Type of risk valued	health improvements due to hypertension therapy. This study is not on reductions in the risk of dying.
Magnitude of the risk	the health change is based on a visual analog scale (VAS), where 0 cm is the worst possible health and 15 cm is the best possible health state.
Magnitude of the risk reduction	subjective change in health with the treatment
population	535 patients on the hypertension register at a primary health care center near Linköping.
sampling frame	questionnaire were mailed to the entire patient roster. The average age of the sample is about 60.
survey method	mail
return rate	335 questionnaires returned, response rate 64%
item nonresponse	very low for the WTP question (only 5%)
date of the survey	1991
elicitation method	polychotomous choice (instead of yes/no, the response categories are def. yes, probably yes, probably not, def. not, don’t know)
subjective or objective risks?	subjective
commodity being valued	antihypertensive treatment, and the related change in health status (a private commodity).

Is the questionnaire reported in the article? Only the wording of the WTP question (in the Appendix)

Do we have questionnaire Available to us? No

Experimental Design people were assigned to one of 15 possible bids, but there is no other meaningful experimental design.

Bid Design 15 bids ranging from 100 to 1500 SEK per month. Specific bids not reported in the article. Percentage yes/no for each bid not reported in the article.

Selection into not discussed in the article

Statistical model used

To estimate mean or Median WTP logit model of the dichotomous choice responses.
bid. WTP is the area under the 1-cdf curve. Three limits of integration were used, 1500, 2000, and 2500 SEK.

Results are compared with non-parametric procedure by Kristrom, which computes the area under the (1-cdf), based on plotting out the cdf.

WTP Regressions? Yes, logit model for the dichotomous choice responses. WTP is treated as a logistic. They experimented with the log logistic distribution as well. Initial round of regression treat any yes (def or probably) as yes, and subsequent rounds focus only on respondents with certain yes and certain nos.

Regressors in WTP Regression bid, Change in VAS, age, sex, education, taxable income.

Results

Mean WTP	Limit of integration 1500 SEK	Limit of integration 2000 SEK	Limit of integration 2500 SEK
Logit model	735	795	855

Annual WTP is 9000 SEK.

Implied VSL N/A

Limitations of the

Study Relative to the earlier study on hypertension, the focus of the study was changed to morbidity. This means that VSL cannot be computed.

Polychotomous choice response categories were used, but their use is not warranted and leaves the researcher with the problem of having to interpret the meaning of the responses and the econometric model.

Summary form 14

Author(s)	Gerking, Shelby, Menno de Haan, and William Schulze
Year of publication	1988
Title	The Marginal Value of Job Safety: A Contingent Valuation Study
Journal details	<i>Journal of Risk and Uncertainty</i> , 1, 185-199
Valuation method	contingent valuation (the survey questionnaire obtains information that can be used to do estimate a compensating wage hedonic model, as was done in a companion paper, Gegax et al. (1987)
Type of risk valued	workplace risks
Magnitude of the risk	X in 4000, with X ranging from 1 to 10; this is annual risk
Magnitude of the risk reduction	1 in 1000
Population	US households
Sampling frame	(a) simple random sample of US households (3000), plus (b) simple random sample from counties with disproportionately high workplace risks (3000).
Of these 6000 mailings, 749 (12.5%) were returned as undeliverable and 2103 completed.	
Survey method	mail survey
Elicitation method	payment card. Responses to the payment card are interpreted as continuous observations on WTP, except if the respondent circles the highest amount on the payment card (\$6001+).
subjective or objective baseline risks?	Baseline risk is subjective. The risk reduction is 1 in 1000 and it objective.
Commodity being valued	WTP for one step down the risk ladder, WTA to accept for one step up on the risk ladder (in split samples). No specific risk reduction delivery method.
Is the questionnaire reported in the article?	No

Do we have the questionnaire**Available to us?** Yes**Were visual aids used?** Yes. Risk ladder, with low and high risk extremes marked to the respondent, and the occupation(s) corresponding to the various risk levels listed.**Experimental Design** In split samples, respondents are asked about WTP or WTA for a step down (or up) on the risk ladder. Across respondent variation in baseline risk, but all respondents are given the same risk reduction (increase in the case of WTA) (=1 in 1000 in a year).**Bid Design** not applicable**Statistical model used
To estimate mean or
Median WTP** Would appear to be just the sample average (but double model is used to run regressions)**WTP Regressions?** Yes**Regressors in WTP
Regression** subjective baseline risk, annual labor earnings, race, gender, age, union membership, schooling**Results** mean WTP = \$665, mean WTA = \$1705**Implied VSL** $VSL = \text{mean WTP or WTA} \times 4000 = \$2.66 \text{ million (WTP)}$
= \$6.82 million (WTA)**Limitations of the
Study** large discrepancy (one order of magnitude) between risks shown to the respondents valued in the study and actual workplace risks.**Other:**
-- large number of zero bids (47.4% in WTP responses, 23.2% in WTA responses)
-- the authors recognize that it may be important to identify or eliminate outliers and protest zeros, but are unwilling to do so for fear of introducing arbitrary criteria for defining an outlier or a protester.
-- attempt to compare the sample of returned questionnaire with the recipients of the mailings

Summary form 15

Author(s)	Timothy McDaniels
Year of publication	1992
Title	“Reference Points, Loss Aversion, and Contingent Values For Auto Safety”
Journal details	Journal of Risk and Uncertainty, 5, 187-200
Valuation method	contingent valuation
Type of risk valued	risk of death in auto accidents (road traffic) (private risk)
Magnitude of the risk	10 in 100,000 (WTP) or 5 in 100,000 (WTA)
Magnitude of the risk reduction	5 in 100,000 risk reduction or 5 in 100,000 increase in risk. WTP for the former, WTA for latter. The questionnaire emphasizes that going from 10 to 5 is halving, and 5 to 10 is doubling.
population	mixed. Questionnaires were handed out to students as well as groups of non-student adults (parents, professionals, staff in an economics consulting firm)
sampling frame	sample is admittedly not representative of the population at large. N=55 and n=194 (auto dealership).
survey method	self-administered in person. Experiment 1 was conducted April-May 1986 at Pennsylvania State University. Experiment 2 was conducted in March 1990 in Washington State.
elicitation method	experiment 1: open ended, experiment 2: dichotomous choice
subjective or objective baseline risks?	Objective
commodity being valued	car safety (through safety features). Private risk reduction.
is the questionnaire reported in the article?	No, but the phrasing of the payment question is.
Do we have questionnaire Available to us?	No

Experimental Design split samples with two experiments. Experiment 1 elicits WTP and WTA for auto safety features that change risk (both WTA and WTP within the subject).

Experiment 2 entails a 2×2 design, where the treatments are (i) WTA v. WTP, and (ii) mentioning or not mentioning the safety of other auto makers (this is the reference). The author checked that the four group were uniform by individual characteristics, and they were.

Bid Design only one bid in experiment 2

Statistical model used experiment 1: mean WTP (mean WTA).
To estimate mean or Median WTP Experiment 2: percentage of “yes” responses to the payment question.

WTP Regressions? No

Regressors in WTP Regression N/A

Results experiment 1: avoiding losses in safety is valuing more highly than gaining safety. Experiment 2: the percentage of “yes” responses to the payment questions varies across the gains/losses context and information about other auto makers’ safety.

Implied VSL experiment 1: \$6.15 million (1986 dollars)

Limitations of the Study

Other: Experiment 1 elicits WTA, WTP for car safety features that change risk (both WTP and WTA eliciting within a subject). 12 protesters with WTA question (these observations were discarded). Seven subjects gave WTP=WTA, 31 WTA/WTP less than 2, 33 WTA/WTP greater than 2). The author also reports that Jones-Lee et al. (1985) finds outliers with WTP or WTA orders of magnitude greater than the other responses.

Appendix B

Selected questionnaires

Corso et al. questionnaire

FINAL: November 10, 1998

Survey II

Hello, my name is _____, and I am calling on behalf of the Harvard School of Public Health. In the last few weeks, someone in your household agreed to participate in a national telephone survey about health and safety issues. May I speak to this same individual [Ms/Mrs/Mr _____]?

Thank you again for agreeing to participate in this survey. Do you have a few moments now to answer the survey questions?

YES

NO*

*Can I set up a more convenient time for the interview?

To assist you in answering these survey questions, you should have already received a packet of materials in the mail. Have you received your packet?

Yes

No [**Confirm address and reschedule time for call back**]

Do you have the packet in front of you?

Yes

No*

*I'd be glad to wait while you locate your packet

Can you please tell me the code # on the cover page of your packet. It is located in the bottom right-hand corner of the page?

[**Record code#**]

If A1: Version A, Linear scale

If A2: Version A, Log scale

If A3: Version A, Dots

If A4: Version A, Control group

If B1: Version B, Linear scale

If B2: Version B, Log scale

If B3: Version B, Dots

If B4: Version B, Control group

Thank you. Now if you are ready, I'd like to begin. This survey will take approximately 25 minutes to complete.

The first few questions that I'd like to ask you relate to how you perceive your quality of life.

Q1. First, think about your current physical and emotional well being, and your involvement in family and community activities. On a scale from 1 to 10, where 10 is the

best you can imagine and 1 is the worst you can imagine, how would you rate your current quality of life?

1 2 3 4 5 6 7 8 9 10

Q2. How would you compare your current quality of life with others of your same age and gender (**READ LIST**)? Is yours...

- 1) Much better
- 2) A little better
- 3) About the same
- 4) A little worse, or
- 5) Much worse
- 6) (Don't know)

****Q3. [SKIP IF AGE > 65]** Now think about what you expect your life to be like as a senior citizen, beginning at age 66. Think about your involvement in family and community activities, and your physical and emotional well being. How would you rate your expected quality of life as a senior on a scale from 1 to 10, where 10 is the best you can imagine and 1 is the worst you can imagine?

1 2 3 4 5 6 7 8 9 10

Section 1: Longevity Lotteries

For the next section of this survey, I want to ask you about the choices that you would make if you developed a serious disease or illness. Please turn to page 1 in your packet. This page should be light YELLOW.

Q4. Imagine that your physician has told you that you have a rare disease. While you experience no pain or impairment from this disease, it is always fatal. Without treatment, it is expected that you will live for only about 8 more years from your current age. Fortunately, there is a painless surgical procedure available to treat your disease. While the surgery can be provided to you free of charge, it is not always successful. 50% of the time, the surgery is successful and you would live about 12 more years. However, 50% of the time, the surgery is unsuccessful and you would live about 4 more years. Would you choose to have the surgery?

YES

NO

Both options are equally preferred

Refused

Don't Know*

*Does this mean that you have no preference between the two options? [**Don't Read]**

YES

No, Choose No Surgery

No, Choose Surgery

No, Don't Know

Q5. After additional testing, your doctor discovers that your disease is not as bad as first suspected. Now, he informs you that you are expected to live for 16 more years without treatment. The chance that surgery will be successful is still uncertain. 50% of the time the surgery is successful and you would live about 24 more years. And 50% of the time the surgery is unsuccessful and you would live about 8 more years. In light of this new information, would you choose to have the surgery?

YES

NO

Both options are equally preferred

Refused

Don't Know*

*Does this mean that you have no preference between the two options? [**Don't Read**]

YES

No, Choose No Surgery

No, Choose Surgery

No, Don't Know

Now turn to page 2 in your packet. This page should also be light YELLOW.

Q6. Now consider an entirely different situation. This time you go to your doctor for a routine physical exam and he informs you that you have developed a rare condition that can lead to a blood clot forming in the brain. Your doctor has told you that a clot like this can form at any time in the next 3 months and is always fatal. Fortunately, there are two pills that can be used to treat your condition. With Pill A, you have an equal chance of living 6 or 10 more years. With Pill B, you have an equal chance of living 4 or 12 more years. If these pills are provided at no expense to you, which pill would you choose to take?

Pill A

Pill B

Both options are equally preferred

Refused

Don't Know*

*Does this mean that you have no preference between the two options? [**Don't Read**]

YES

No, Choose Pill A

No, Choose Pill B

No, Don't Know

Q7. What if the chance of success for Pill B has changed? Now with Pill B, you have a 90% chance of living 6 more years and a 10% chance of living 26 more years [**Version**

B: ..., you have a 70% chance of living 11 more years and a 30% chance of living only 1 more year]. If you now had to choose between Pill A and Pill B, which pill would you choose?

- Pill A
- Pill B/revised
- Both Options are equally preferred
- Refused
- Don't Know*

*Does this mean that you have no preference between the two options? [**Don't Read]**

- YES
- No, Choose Pill A
- No, Choose Pill B/Revised
- No, Don't Know

Now turn to page 3 in your packet. This page should also be light YELLOW.

Q8. Now imagine that a pharmaceutical company has developed a new type of treatment for your condition. With Pill C, you have an equal chance of living 14 or 18 more years. With Pill D, you have an equal chance of living 12 or 20 more years. If this new medication is offered to you free of charge, which pill would you choose?

- Pill C
- Pill D
- Both options are equally preferred
- Refused
- Don't Know*

*Does this mean that you have no preference between the two options? [**Don't Read]**

- YES
- No, Choose Pill C
- No, Choose Pill D
- No, Don't Know

Q9. Now thinking about the choices that you have made between having surgery and not having surgery or choosing between the pill options, how confident are you in your previous responses?

Are you...?

- Very confident
- Somewhat confident
- Not too confident
- Not at all confident
- DK

Section2: Attitudes and Beliefs about Prevention and Treatment

For the next section, I'd like to ask your opinion about SOCIETAL programs that the federal government might adopt to help control health problems in the US. You do not need the packet of materials for this section.

An important question in the health care sector is how to allocate scarce resources between preventive measures that save lives by preventing disease and promoting health and treatment efforts that save lives among persons already suffering from disease.

Prevention and treatment differ in many ways.

1. Prevention interventions are generally applied to a group of individuals or a population, although typically only a fraction of those individuals would have ultimately gotten the disease without the intervention. An example of a prevention intervention is diet or medicine to lower cholesterol to PREVENT heart attacks.
2. Treatment interventions are generally applied to individuals who already have a disease. An example of a treatment intervention is medicine or surgery to TREAT heart failure after a heart attack.

[Version A: Ask Q10 first; Version B: Ask Q11 first]

Q10. On a scale from 1 to 10, where 1 means not at all effective and 10 means very effective, how effective do you think prevention programs are in reducing health problems in the US?

1 2 3 4 5 6 7 8 9 10

Q11. On a scale from 1 to 10, where 1 means not at all effective and 10 means very effective, how effective do you think treatment programs are in reducing the health problems in the US?

1 2 3 4 5 6 7 8 9 10

Q12. If a prevention program and treatment program both saved the same number of lives from the same health problem, which program do you think would be more costly for society?

- Prevention Program
- Treatment Program
- Same cost
- Don't Know/Refused

Section 3: WTP for Prevention or Treatment

For the next section of this survey, I'd like to ask you a few questions about food safety. Please turn to page 4 in your packet. This page should be light GREEN.

[Version A: SKIP Q14; Version B: SKIP Q13]

Q13a. Imagine that you are planning a trip to a foreign country where for every 100,000 people visiting per year, 400 people contract a virus from eating contaminated food. If you get the virus, the only symptom is a slight yellowing of the skin for 2 or 3 days. The virus causes no other discomfort and does not interfere with any of your activities.

However, studies have shown that for every 100 people who get the virus, 1 will die. Further, there is no treatment at this time. Fortunately, there is a US medication available that will protect you from getting the virus in the first place, no matter what foods you eat while traveling. This medication has NO side effects. Tests have shown that this preventive medicine will decrease your risk of getting the virus by 50%. Thus, your overall chances of dying from this illness can be reduced from 4 in 100,000 to 2 in 100,000 if you take the preventive medicine.

Would you consider taking the medication before traveling?

Yes (skip to Q13c)

No

Don't Know

Q13b. What is the main reason you would not be willing to take the medication before traveling? **[Prompt if needed]**

Benefits too small (skip to Q15)

Uncertain about benefits (skip to Q15)

Don't like receiving medication (skip to Q15)

Concerned about safety of medication (skip to Q15)

Other (specify) (skip to Q15)

DK/Refused (skip to Q15)

[Link dollar amounts]

Q13c. Now assume that you would have to pay some money to get this medication -- insurance would not cover it. Considering your current income and other household expenses, would you pay **(\$50, \$100, \$200)** for this medication before you leave on your trip?

Yes (skip to Q13f)

No

DK/Refused

Q13d. Would you buy this medication if the out-of-pocket cost was **(\$20, \$50, \$100)**?

Yes (skip to Q13g)

No

DK/Refused

Q13e. What is the main reason you would not pay for the medication before your trip?
[PROMPT IF NEEDED]

Too expensive/costs too much (skip to Q15)

Somebody else should pay (insurance etc.) (skip to Q15)
 Benefits too small (skip to Q15)
 Uncertain about benefits (skip to Q15)
 Benefits not worth the cost (skip to Q15)
 Don't like receiving medication (skip to Q15)
 Concerned about safety of medication (skip to Q15)
 Other (specify) (skip to Q15)
 DK/Refused (skip to Q15)

Q13f. Would you buy this medication if the out-of-pocket cost was **(\$100, \$200, \$400)**?

Yes
 No
 DK/Refused

Q13g. How confident are you about the amount you would be willing to pay for this medication? Are you...

Very confident
 Somewhat confident
 Not too confident
 Not at all confident
 DK

Q14a. Imagine that while traveling in a foreign country you notice that your skin has been slightly yellow for 2 or 3 days. While you experience no other discomfort and have been able to conduct your normal activities, you decide to visit a local clinic run by US doctors.

The doctors tell you that you have contracted a virus, probably from eating contaminated food, where for every 100,000 people who have the virus, 4 will die. Fortunately there is a US medication available at the clinic. This medication has NO side effects. Tests have shown that this medication will reduce your chance of dying by 50%. Thus your overall chance of dying from this virus can be reduced from 4 in 100,000 to 2 in 100,000.

Would you consider taking the medication?

Yes (skip to Q14c)
 No
 Don't Know

Q14b. What is the main reason you would not be willing to take the medication?

[Prompt if needed]

Benefits too small (skip to Q15)
 Uncertain about benefits (skip to Q15)
 Don't like receiving medication (skip to Q15)
 Concerned about safety of medication (skip to Q15)
 Other (specify) (skip to Q15)
 DK/Refused (skip to Q15)

[Link dollar amounts]

Q14c. Now assume that you would have to pay some money to get this medication -- insurance would not cover it. Considering your current income and other household expenses, would you pay **(\$50, \$100, \$200)** for this medication?

Yes (skip to Q14f)

No

DK/Refused

Q14d. Would you buy this medication if the out-of-pocket cost was **(\$20, \$50, \$100)**?

Yes (skip to Q14g)

No

DK/Refused

Q14e. What is the main reason you would not pay for this medication to treat your foodborne illness? **[PROMPT IF NEEDED]**

Too expensive/costs too much (skip to Q15)

Somebody else should pay (i.e., insurance) (skip to Q15)

Benefits too small (skip to Q15)

Uncertain about benefits (skip to Q15)

Benefits not worth the cost (skip to Q15)

Don't like receiving medication (skip to Q15)

Concerned about safety of medication (skip to Q15)

Other (specify) (skip to Q15)

DK/Refused (skip to Q15)

Q14f. Would you buy this medication if the out-of-pocket cost was **(\$100, \$200, \$400)**?

Yes

No

DK/Refused

Q14g. How confident are you about the amount you would be willing to pay for this medication? Are you...

Very confident

Somewhat confident

Not too confident

Not at all confident

DK

Q15. How serious do you think the risk of dying is from contracting a foodborne virus while traveling in a foreign country: if 1 means not at all serious and 10 means very serious?

1

2

3

4

5

6

7

8

9

10

Q16. Assume that the government has to make a choice between 2 equally costly programs, A and B, both of which could save the lives of US residents traveling in foreign countries who are at risk of contracting a virus from eating contaminated food.

Which program would you choose if...

- Program A saves the lives of 100 American travelers per year by providing preventive medicine to all persons who are planning to travel to a foreign country.
- AND
- Program B saves the lives of 100 American travelers per year by treating those persons who have already contracted the virus during their travels in a foreign country?

PROGRAM A

PROGRAM B

Both are Equally Preferred (skip to Q18b)

Don't Know/Refused (skip to next section)

Q17. How much better would it be to invest in the project that you chose?

Extremely better

Much better

Somewhat better

Only a little better

No better **[Don't read aloud: Mark if they answer 'Both are Equally Preferred' on Q16]**

Q18a. What is the main reason you preferred Program ____ over Program ____? **[OPEN-ENDED]**

(skip Q18b)

Q18b. What is the main reason you have no preference between Program A and Program B? **[OPEN-ENDED]**

Section 4: Automobile Safety

[Read if Versions A1, A2, A3, B1, B2, or B3]: For the next two sections, I'd like you to use the visual aid located on the last page of your packet. On Page 5, we provide a brief description of the **[Version A3 and B3: dots; Version A1, A2, B1, B2: risk scale]** visual aid. Would you like a few moments to read through this description? **[Allow time as needed].**

[Read if Version A4 or B4]: For the remainder of the survey, you do not need to look at your packet of materials.

Now I'd like to ask you several questions related to automobile safety and the use of airbags to prevent injuries and deaths in the event of an automobile accident.

Q19. Do you have an airbag in any of the vehicles in your household?

Yes

No

DK/Refused

Q20. How effective do you think airbags are in preventing death and injury in automobile accidents?

Very effective

Somewhat effective

Not too effective

Not at all effective

DK/ No opinion/Refused

Q21.

Version A1, A2, B1, B2

A1 and A2: Based on government statistics, the average driver in the US has about 2 (B1 and B2: 2.5) chances in 10,000 of being killed in a crash in any given year. On your risk ladder, please note that the highest star symbol in blue represents your baseline annual risk of dying in an automobile accident. In community terms it means that you could expect to find about 2 people per year killed by an automobile accident in every small town in the US. (B1 and B2: about 2.5 people killed by an automobile accident in every small town in the US). On a scale from 1 to 10, with 10 being very concerned and 1 being not at all concerned, how concerned are you about the risk of dying in an automobile accident?

1 2 3 4 5 6 7 8 9 10

Version A3 and B3:

A3: Based on government statistics, the average driver in the US has about 2 (B3: 2.5) chances in 10,000 of being killed in a crash in any given year. On your visual aid, a 2 in 10,000 risk is equal to 5 dots on the page (B3: equal to about 6 dots). On a scale from 1 to 10, with 10 being very concerned and 1 being not at all concerned, how concerned are you about the risk of dying in an automobile accident?

1 2 3 4 5 6 7 8 9 10

Version A4 and B4:

A4: Based on government statistics, the average driver in the US has about 2 (B4: 2.5) chances in 10,000 of being killed in a crash in any given year. On a scale from 1 to 10, with 10 being very concerned and 1 being not at all concerned, how concerned are you about the risk of dying in an automobile accident?

1 2 3 4 5 6 7 8 9 10

Q22. Thinking about your personal situation, how would you judge your chances of being killed in a traffic accident...

- Much larger than average
- Somewhat larger than average
- About average
- Somewhat smaller than average
- Much smaller than average
- DK/Refused

Version A1, A2, B1, B2

A1 and A2: Now I would like to ask you a question about your willingness to pay money for a new safety device that can be installed in cars to protect drivers. It works like an airbag but protects drivers in a side impact rather than in a head-on crash. This device is well tested, safe and reliable. For the typical driver, this new device will reduce the yearly chance of dying in a crash from 2 in 10,000 (**B1 and B2: 2.5 in 10,000**) to 1.5 in 10,000. Please note on your risk ladder that the lowest star symbol in blue represents your annual risk of dying in an automobile crash when a side-impact airbag is added to your vehicle. In community terms it means that during one year you could expect to find on average 1.5 people killed in an automobile accident in every small town in the US.

Version A3 and B3

A3: Now I would like to ask you a question about your willingness to pay money for a new safety device that can be installed in cars to protect drivers. It works like an airbag but protects drivers in a side impact rather than in a head-on crash. This device is well tested, safe and reliable. For the typical driver, this new device will reduce the yearly chance of dying in a crash from 2 in 10,000 (**B3: 2.5 in 10,000**) to 1.5 in 10,000. On your visual aid, a 1.5 in 10,000 risk is equal to about 4 dots on the page. Thus, by adding a side-impact airbag, your risk is reduced from 2 in 10,000, or 5 dots on the page -- to 1.5 in 10,000, or about 4 dots on the page. (**B3: ... from 2.5 in 10,000, or about 6 dots on the page -- to ...**).

Version A4 and B4

A4: Now I would like to ask you a question about your willingness to pay money for a new safety device that can be installed in cars to protect drivers. It works like an airbag but protects drivers in a side impact rather than in a head-on crash. This device is well tested, safe and reliable. For the typical driver, this new device will reduce the yearly chance of dying in a crash from 2 in 10,000 (**B4: 2.5 in 10,000**) to 1.5 in 10,000. Thus, by adding a side-impact airbag, your risk is reduced from 2 in 10,000 to 1.5 in 10,000. (**B4: ... from 2.5 in 10,000 to ...**).

Q23. If this device were offered as an option on the next car you buy, would you be willing to pay \$100 more per year in car payments for five years to have this device in your car?

- YES (skip to Q25)
- NO

Don't Know/Refused

Q24. Would you be willing to pay \$50 more per year in car payments for five years to have this device in your car?

Yes (go to Q26)

No (go to Q26)

DK/Refused (go to Q26)

Q25. Would you be willing to pay to pay \$200 more per year in car payments for five years to have this device installed in your car?

Yes

No

DK/Refused

Q26. Now thinking about your household income and other expenses, how confident are you in your previous answers about what you would be willing to pay for a side-impact airbag?

Very confident

Somewhat confident

Not too confident

Not at all confident

DK/Refused

Section 5: Blood Safety

Now, I would like to ask you some questions about the safety of the blood supply used by hospitals.

[Read if Version A1, A2, A3, B1, B2, B3]: Again, please refer to the visual aid on the last page of your packet.

When surgery is performed, a patient will often require a blood transfusion. The needed blood is usually supplied by someone else. If the donated blood is infected with viruses, the patient receiving the blood can develop a serious illness such as Hepatitis or HIV, the Human Immunodeficiency Virus. Hospitals screen blood donors to prevent this problem but no tests are perfect and there is a chance that patients will contract Hepatitis or HIV from donated blood.

Q27. Before I go on, have you ever had surgery in the hospital?

Yes

No

DK/Refused

Q28. Have you ever donated blood?

Yes

No

DK/Refused

Suppose that in the future you decide to undergo elective surgery to reduce chronic chest pain that, while painful, does not threaten your life. Your doctor advises you that a blood transfusion will be required during surgery. Although blood donors are well screened, there is a chance that you will contract either Hepatitis or HIV from the transfusion.

Hepatitis is like a very bad flu. It typically causes nausea and weight loss, and often lasts a few weeks. In rare cases, it can cause death.

HIV, which leads to AIDS or Acquired Immunodeficiency Syndrome, is almost always fatal. However, people infected with the AIDS virus can often lead normal lives at least 10 years or more before their symptoms become severe and eventually fatal.

Version A1, A2, B1, B2

The chance of contracting Hepatitis from a blood transfusion is about 3 in 10,000. On your risk ladder, please note that the highest triangle symbol in green represents your risk of contracting Hepatitis from a blood transfusion. In community terms this means that if everyone in a small town received a blood transfusion in one year, 3 people would contract Hepatitis from the transfusion.

The chance of contracting HIV from a blood transfusion is about 4 in one million. On your risk ladder, please note that the highest circle symbol in red represents your risk of contracting HIV from a blood transfusion. In community terms this means that if everyone in a city received a blood transfusion in one year, 1 person would contract HIV from the transfusion.

Version A3 and B3

The chance of contracting Hepatitis from a blood transfusion is about 3 in 10,000. On your visual aid, a 3 in 10,000 risk is equal to 7 1/2 dots on the page. The chance of contracting HIV from a blood transfusion is about 4 in 1 million. On your visual aid, a 4 in 1 million risk is equal to 10% of 1 dot on the page.

Version A4 and B4

The chance of contracting Hepatitis from a blood transfusion is about 3 in 10,000. The chance of contracting HIV from a blood transfusion is about 4 in 1 million.

[Randomly ask Q29a, Q29b, OR Q29c]

Q29a. Your doctor can order that the blood be tested with a special viral-screening test to reduce the risks associated with blood transfusion, but you must pay an out-of-pocket charge that is not covered by insurance. The special test reduces the chance of developing HIV from 4 in 1 million to 1 in 100 million. The test does not detect the Hepatitis virus, so the risk of Hepatitis is not reduced by the test.

Version A1, A2, B1, B2

On your risk ladder, please note that the lowest circle symbol in red represents your risk of contracting HIV from a blood transfusion, after screening of the blood. In community terms this means that if everyone in a large country received a blood transfusion in one year, one person would be infected with HIV from the transfusion.

Version A3 and B3

On your visual aid, a 1 in 100 million probability is equal to one ten-thousandth of one dot on the page.

Q29b. Your doctor can order that the blood be tested with a special viral-screening test to reduce the risks associated with blood transfusion, but you must pay an out-of-pocket charge that is not covered by insurance. The special test reduces the chance of contracting **Hepatitis** from 300 in 1 million to 1 in 100 million. The test does not detect HIV, so the risk of HIV is not reduced by the test.

Version A1, A2, B1, B2

On your risk ladder, please note that the lowest triangle symbol in green represents your risk of contracting Hepatitis from a transfusion, after screening of the blood. In community terms this means that if everyone in a large country received a blood transfusion in one year, one person would be infected with Hepatitis from the transfusion.

Version A3 and B3

On your visual aid, a 1 in 100 million probability is equal to one ten-thousandth of one dot on the page.

Q29c. Your doctor can order that the blood be tested with a special viral-screening test to reduce the risks associated with blood transfusion, but you must pay an out-of-pocket charge that is not covered by insurance. The special test reduces the chance of developing **either Hepatitis or HIV** to 1 in 100 million. That is, the risk of contracting Hepatitis is reduced from 300 in 1 million to 1 in 100 million and the risk of contracting HIV is reduced from 4 in 1 million to 1 in 100 million.

Version A1, A2, B1, B2

On your risk ladder, please note that the lowest circle in red represents your risk of contracting HIV from a transfusion, after screening of the blood. The lowest triangle in green represents your risk of contracting Hepatitis from a transfusion, after screening of the blood. In community terms this means that if everyone in a large country received a blood transfusion in one year, one person would be infected with HIV and one person would be infected with Hepatitis from the transfusion.

Version A3 and B3

On your visual aid, a 1 in 100 million probability is equal to 1 ten-thousandth of one dot on the page.

[for Q30-Q32, link dollar amounts]

Q30. Would you elect the special blood-screening test if the out-of-pocket charge is **[\$100, \$250, \$500, \$700, \$1500]**?

Yes

No (skip to Q32)

DK/Refused (skip to Q32)

Q31. Would you elect the special blood screening test if the out-of-pocket charge is **[\$200, \$500, \$1000, \$1200, \$3000]**?

Yes (skip to Q33)

No (skip to Q33)

DK/Refused (skip to Q33)

Q32. Would you elect the special blood-screening test if the out-of-pocket charge is **[\$50, \$100, \$200, \$500, \$700]**?

Yes

No

DK/Refused

Q33. Now thinking about your household income and other expenses, how confident are you in your previous answers about how much you would be willing to pay for the special blood test?

Very confident

Somewhat confident

Not too confident

Not at all confident

DK/Refused

****Section 6: WTP for Pneumonia**

[Version A: END if age 60+; Version B: END if age 70+]

For the final set of questions, I would like to ask you about measures you might want to take to prevent Pneumonia and how much they would be worth to you. For this final section of this survey, you do NOT need to look at your packet.

Pneumonia is a serious disease. It is characterized by severe flu-like symptoms and a build-up of fluids in the lungs, and often causes death in older people. For a person of your age and gender, the average chance of living to age 60 (**Version B: ...to age 70**) and older is **[percentage from chart]**.

		Version A:		Version B:	
		Male	Female	Male	Female
18-29		84%	91%	67%	80%

30-39	86%	92%	68%	81%
40-49	89%	93%	70%	82%
50-59	94%	97%	75%	85%
60-70	NA	NA	87%	92%

Q34. How would you rate your chance of living to age 60 (**Version B: ...to age 70**), compared with others of your age and gender? Is your chance...

- Much higher
- A little higher
- About the same
- A little lower
- Much lower
- DK

[Randomize: ask either Q35a OR Q35b]

Q35a. On average, a person aged 60 has a life expectancy of 21 years. That is, the average 60-year-old will live to age 81. (**Version B: On average, a person aged 70 has a LE of 14 years. That is, the average 70-year-old will live to age 84**).

Suppose that a Pneumonia vaccine will be available to you at age 60 (**B: age 70**). The vaccine is perfectly safe and if you get vaccinated on your 60th (**B: 70th**) birthday, your life expectancy will increase from 21 years to 21 years and 11 months (**B: from 14 years to 14 years and 5 months**). Would you consider getting the vaccine at age 60 (**B: ...age 70**)?

- Yes (skip to Q37)
- No
- DK

Q35b. On average, a person aged 60 has a 4.8% probability of dying each year from all causes. That is, the average chance of living at least one more year is 95.2%. (**Version B: On average, a person aged 70 has a 7% probability of dying each year from all causes. That is, the average chance of living at least one more year is 93%**).

Suppose that a Pneumonia vaccine will be available to you at age 60 (**B: 70**). The vaccine is perfectly safe and if you get vaccinated on your 60th (**B: 70th**) birthday, your annual probability of dying each year would decrease from 4.8% to 4.6% (**B: ...from 7% to 6.8%**). That is, your annual probability of surviving each year will increase from 95.2% to 95.4% (**B: from 93% to 93.2%**). Would you consider getting the vaccine at age 60 (**B: age 70**)?

- Yes (skip to Q37)
- No
- DK

Q36. What is the main reason you would not be willing to get vaccinated against Pneumonia [**Prompt if needed**]?

- Benefits too small (skip to End)
- Uncertain about benefits (skip to End)
- Don't like receiving injections/vaccines (skip to End)
- Concerned about safety of vaccine/injection (skip to End)
- Other (specify) (skip to End)
- DK/Refused (skip to End)

Q37. Now assume that you would have to pay some money this year to have the vaccine available to you when you reach age 60 (**B: age 70**). Assume that you would need to pay this cost out of your own pocket; it would not be covered by insurance. Also assume that no better vaccine would become available before you reach age 60 (**B: age 70**).

Considering your current income and expenses, would you pay (**randomize: \$220, \$400, \$750**) this year to have the vaccine available for you on your 60th (**B: 70th**) birthday?

- Yes (skip to Q40)
- No
- DK/Refused

Q38. If it cost only (**\$40, \$80, \$130**), would you pay this year to have the vaccine available to you on your 60th (**B: 70th**) birthday?

- Yes (skip to Q41)
- No
- DK/Refused

Q39. What is the main reason you would not pay to have yourself vaccinated against pneumonia [**Prompt if needed**]?

- Too expensive/costs too much (skip to Q41)
- Benefits too small (skip to Q41)
- Uncertain about benefits (skip to Q41)
- Benefits not worth the cost (skip to Q41)
- Don't like receiving medication (skip to Q41)
- Concerned about safety of medication (skip to Q41)
- Somebody else should pay (skip to Q41)
- Other (specify) (skip to Q41)
- DK/Refused (skip to Q41)

Q40. Would you pay (**\$700, \$1,500, \$3,500**) this year to have the vaccine available to you on your 60th (**B: 70th**) birthday?

- Yes
- No
- DK/Refused

Q41. How confident are you about whether you would pay to get the Pneumonia vaccine?

- Very confident
- Somewhat confident
- Not too confident

Not at all confident
DK

END: This completes the survey. On behalf of the Harvard School of Public Health, we'd like to thank you very much for your participation in this study.

Johannesson and Johannesson (1996) questionnaire

June 95

Business**School**

July 95

1 **Serial number****Cost of operation in questions 2 and 3**

- 6 A 100 kronor
 B 500 kronor
 C 1,000 kronor
 D 5,000 kronor
 E 15,000 kronor
 F 50,000 kronor

FOR WOMEN**1920 - 1934:**

A woman of your age has an 85% chance of reaching the age of at least 75. A 75-year-old lives an average of 10 more years.

1935 - 1954:

A woman of your age has an 80% chance of reaching the age of at least 75. A 75-year-old lives an average of 10 more years.

1955 - 1978:

A woman of your age has a 75% chance of reaching the age of at least 75. A 75-year-old lives an average of 10 more years.

FOR MEN**1920 - 1934:**

A man of your age has a 75% chance of reaching the age of at least 75. A 75-year-old lives an average of 10 more years.

1935 - 1954:

A man of your age has a 65% chance of reaching the age of at least 75. A 75-year-old lives an average of 10 more years.

1955 - 1976:

A man of your age has a 60% chance of reaching the age of at least 75. A 75-year-old lives an average of 10 more years.

9. Gender

- | | | |
|----|---|--------|
| 17 | 1 | Female |
| | 2 | Male |

- | | | |
|----|--|------------------------------------|
| 18 | | 10. County code
2-digits |
|----|--|------------------------------------|

- | | | |
|----|---|---|
| 20 | | 11. Regional breakdown |
| | 1 | Norrland (counties X, Y, Z, AC and BD) |
| | 2 | Stockholm county (county A) |
| | 3 | Rest of Svealand (counties C, D, S, T, U and W) |
| | 4 | Eastern Götaland (counties E, F, G, H, I and K) |
| | 5 | Southern Götaland (counties K, L and M) |
| | 6 | Western Götaland (counties O, P and R) |

- | | | |
|----|---|---|
| 21 | | 12. Type of area where you live |
| | 0 | Non-urban |
| | 1 | Metropolitan Stockholm, Gothenburg or Malmö |

Johannesson et al. (1997) questionnaire

Sept. 1996

Serial no.							Date		
Interviewer					Time..... To.....				

1 **Serial number**

5 **Blank**

6 **Secondary choices**

- A 300 kronor in questions 2 and 3
- F 500 kronor in questions 2 and 3
- H 1,000 kronor in questions 2 and 3
- O 2,000 kronor in questions 2 and 3
- R 5,000 kronor in questions 2 and 3
- X 10,000 kronor in questions 2 and 3

7 **Blank**

1. In what year were you born?

Year 19

--	--

10 **Blank**

IF BORN IN 1957 OR BEFORE:

FOR MEN: It is estimated that roughly 10 men out of 10,000 of your age will die in the next year.

Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying next year from 10 to 8 in 10,000.

FOR WOMEN: It is estimated that roughly 6 women out of 10,000 of your age will die in the next year.

Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying next year from 30 to 28 in 10,000.

IF BORN 1947-1956:

FOR MEN: It is estimated that roughly 30 men out of 10,000 of your age will die in the next year.

Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying next year from 30 to 28 in 10,000.

FOR WOMEN: It is estimated that roughly 20 women out of 10,000 of your age will die in the next year.

Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying next year from 20 to 18 in 10,000.

IF BORN 1937-1946:

FOR MEN: It is estimated that roughly 70 men out of 10,000 of your age will die in the next year.

Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying next year from 70 to 68 in 10,000.

FOR WOMEN: It is estimated that roughly 40 women out of 10,000 of your age will die in the next year.

Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying next year from 40 to 38 in 10,000.

IF BORN 1936 OR BEFORE:

FOR MEN: It is estimated that roughly 200 men out of 10,000 of your age will die in the next year.

Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying next year from 200 to 198 in 10,000.

FOR WOMEN: It is estimated that roughly 100 women out of 10,000 of your age will die in the next year.

Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying next year from 100 to 98 in 10,000.

2. Would you buy this treatment at present if it cost you XXX kronor?

☐ 1 Yes

☐ 2 No

11

12 **Blank**

IF YES: **3. Are you fairly certain or totally certain that you would buy this treatment if it cost you XXX kronor?**

☐ 1 Totally certain

☐ 2 Fairly certain

13

14 **Blank**

The next question concerns the quality of life you imagine having during the next year. Assume that the highest possible quality of life is rated at 10, and that the lowest possible quality of life is rated at 1.

4. Rate the quality of life you believe you will have during the coming year on a scale of 1 to 10.

15

--	--

 (between 1 and 10)

17 **Blank**

5. How many people, including yourself, live in the same household as you?

18 Number of people

--

19 **Blank**

6. Are you married or living with someone?

- ☐ 1 No
☐ 2 Yes, married
☐ 3 Yes, living with someone
 20

21 **Blank**

7. How much education have you had?

- ☐ 1 9 years or less, e.g. nine-year compulsory school, elementary school, junior secondary school
☐ 2 10 - 12 years, e.g. upper secondary college-preparatory school, trade school, girls' school
☐ 3 13 years or more, e.g. university studies
 22

23 **Blank**

8. Approximately how large is your own monthly income before taxes? Include pensions, but not study allowances.

24 Thousands of kronor before taxes:

--	--

26 **Blank**

IF MARRIED OR LIVING WITH SOMEONE:

9. Approximately how large is your own and your spouse's/cohabitant's combined monthly income before taxes? Include pensions, but not study allowances.

27 Thousands of kronor before taxes:

--	--

28 **Blank**

**10. Do you live in
READ THE CHOICES ALoud!**

- ☐ 1 A large city with more than 200,000 inhabitants
☐ 2 A town with 81,000 - 200,000 inhabitants
☐ 3 A town with 21,000 - 80,000 inhabitants
☐ 4 A place with 20,000 or fewer inhabitants
 30

31 **Blank**

11. Gender

- ☐ 1 Female
☐ 2 Male
 32

33 **Blank**

12. Region

- 34 1 Norrland (counties X, Y, Z, AC and BD)
 2 Stockholm county (county A)
 3 Rest of Svealand (counties C, D, S, T, U and W)
 4 Eastern Götaland (counties E, F, G, H, I and K)
 5 Southern Götaland (counties L, M and N)
 6 Western Götaland (O, P and R counties)

35 **Blank**

13. Type of area where you live

- 36 0 Non-urban
 1 Urban (metropolitan Stockholm, Gothenburg or Malmö)

37 **Blank**

14. Weighting with respect to gender, age and region

38 10 positions

Persson et al. (2001) questionnaire

[University emblem] TRAFFIC ENGINEERING DIVISION

IHE

LUND INSTITUTE OF TECHNOLOGY

The Swedish Institute for

LUND UNIVERSITY

Health Economics

[illegible]

How do you perceive the traffic risks when
you walk, bicycle, drive a car,
moped or motorcycle, or when you use public transportation?

BACKGROUND QUESTIONS

We would like to begin by asking you a few questions about yourself and your travel habits. Note that the question about how far you drive and/or travel by car refers to travel per **year**, while this question regarding other means of transportation refers to travel per **week**. For all means of transportation, except for car, that question is also subdivided into the winter (October – March) and summer (April – September) months.

1. Are you? ☐ Male
☐ Female
-

2. How old are you?
_____ years
-

3. How many people live in your household, and how old are they?
Do not forget to include yourself.
- _____ 0-3 yrs
_____ 4-10 yrs
_____ 11-17 yrs
_____ 18 and above
-

4. Does your household have access to a car?
- ☐ Yes
☐ No
-

5. If the back seat is equipped with a seat belt, do you wear it when seated there?
- ☐ Yes
☐ No
☐ Sometimes
-

6. Do you use a bicycle helmet when you bicycle?
- ☐ I never bicycle
☐ Yes
☐ No
☐ Sometimes
-

-
7. How many Swedish miles [1 Swedish mile = 10 km] do you drive and/or travel by car per *year*?

- ☐ I never drive or travel by car
 - ☐ 1 – 999 Swedish miles
 - ☐ 1000 – 1499 Swedish miles
 - ☐ 1500 – 1999 Swedish miles
 - ☐ 2000 – 2499 Swedish miles
 - ☐ 2500 Swedish miles or more
-

8. How many km do you travel by any of the following means of public transportation during a *typical week*?

Bus, street car, commuter train, train or subway

- a) During the winter months (October – March)?

- ☐ I do not normally use public transportation during the winter months
- ☐ Less than 100 km
- ☐ 100 – 249 km
- ☐ 250 – 399 km
- ☐ 400 km or more

- b) During the summer months (April – September)?

- ☐ I do not normally use public transportation during the summer months
 - ☐ Less than 100 km
 - ☐ 100 – 249 km
 - ☐ 250 – 399 km
 - ☐ 400 km or more
-

9. If you normally do not use public transportation during the summer and winter months, what is your reason for not using public transportation?

- ☐ There are no connections to and from my normal destination
 - ☐ Departure and arrival times do not fit my schedule
 - ☐ I have to have a car for my job
 - ☐ It seems too much of an effort/too impractical to use public transportation
 - ☐ Other, please specify _____
-

10. How many km do you walk by foot in trafficked areas during a *typical week*?

a) During the winter months (October – March)?

- ☐ I do not normally walk by foot in trafficked areas during the winter months
- ☐ Less than 10 km
- ☐ 10 – 19 km
- ☐ 20 – 39 km
- ☐ 40 km or more

b) During the summer months (April – September)?

- ☐ I do not normally walk by foot in trafficked areas during the summer months
- ☐ Less than 10 km
- ☐ 10 – 19 km
- ☐ 20 – 39 km
- ☐ 40 km or more

11. How many km do you bicycle during a *typical week*?

a) During the winter months (October – March)?

- ☐ I do not normally bicycle during the winter months
- ☐ Less than 25 km
- ☐ 25 – 49 km
- ☐ 50 – 99 km
- ☐ 100 km or more

b) During the summer months (April – September)?

- ☐ I do not normally bicycle during the summer months
- ☐ Less than 25 km
- ☐ 25 – 49 km
- ☐ 50 – 99 km
- ☐ 100 km or more

12. How many km do you drive a moped during a *typical week*?

a) During the winter months (October – March)?

- ☐ I do not normally drive a moped during the winter months
- ☐ Less than 50 km
- ☐ 50 – 99 km
- ☐ 100 – 199 km

☐ 200 km or more

b) During the summer months (April – September)?

☐ I do not normally drive a moped during the summer months

☐ Less than 50 km

☐ 50 – 99 km

☐ 100 – 199 km

☐ 200 km or more

13. How many km do you drive and/or ride with someone on a motorcycle during a *typical week*:

a) During the winter months (October – March)?

☐ I do not normally drive and/or ride with someone on a motorcycle during the winter months

☐ Less than 100 km

☐ 100 – 249 km

☐ 250 – 399 km

☐ 400 km or more

b) During the summer months (April – September)?

☐ I do not normally drive and/or ride with someone on a motorcycle during the summer months

☐ Less than 100 km

☐ 100 – 249 km

☐ 250 – 399 km

☐ 400 km or more

14. a) Have you ever been injured in a traffic accident? “Injured” means here seriously enough to require medical care.

☐ Yes

☐ No

b) Have you been injured in a traffic accident during the past year?

☐ Yes

☐ No

c) Has anyone else in your household been injured in a traffic accident during the past year?

☐ Yes

☐ No

15. As a way to assess how good or poor a person's health condition is, we have provided the thermometer-like scale to the right. On it, the best imaginable health condition is marked 100 and the worst condition imaginable is marked 0.

**Best imaginable
condition**

100

We would like you to use the scale to mark how good or poor your health is, in your own opinion. Do this by drawing a line from the box below to the point on the scale that best corresponds to how good or poor your current health condition is.

[scale]

Your current health condition

0

**Worst imaginable
condition**

RISK OF DYING

Most activities that we as human beings perform involve exposing ourselves to different kinds of risks. In the grid on the page to the right, a few different risks of dying are illustrated. There are 100,000 squares in the grid. Each square represents an individual 50 years of age.

The hatched area corresponds to the number of individuals in their fifties per 100,000 people who die on average during a year in Sweden. The risk of dying for individuals in their fifties is 300 in 100,000. That means that in an area where 100,000 inhabitants are in their fifties, 300 of them will die during one year.

The squares marked in black correspond to the number of individuals in their fifties in 100,000 who, during an average year in Sweden, die of the following causes:

The risk of dying of heart disease is 54 in 100,000

The risk of dying of cancer in the stomach or esophagus is 6 in 100,000

The risk of dying in a traffic accident is 5 in 100,000

Below are questions about your perception of
the risk of *dying*

In an average year, the risk of dying is 300 in 100,000 for individuals in their fifties.

16. How great do you think *your own risk of dying* is during the coming year? Your own risk may be higher or lower than the average. Consider your age and your current state of health.

I think the risk is _____ in 100,000

[grid]

The risk of dying is 300 in 100,000

The risk of dying from heart disease is 54 in 100,000

[hatched area and black squares]

The risk of dying in a traffic accident is 5 in 100,000

The risk of dying of cancer in the stomach or esophagus is 6 in 1000,000

In the following question, we would like you to answer how much you personally would be willing to pay for safety equipment and preventive health care that would reduce your own risk of *dying* by 10%. Before you decide how the maximum that you- would be willing to pay, we ask you to consider the following conditions:

- The risk reduction only applies to the risk of dying. The risk of being injured or sustaining permanent impairment is not included.
 - The safety equipment and preventive health care do not entail any sacrifices or inconveniences etc. You are the only benefiting from these measures. Nobody else's risk factor is involved.
 - The safety equipment and preventive health care would be effective during a single year only. You would subsequently have to renew payment if you wanted to continue to benefit from risk reduction.
 - If you die, your family's finances will not suffer, since it is assumed that the insurance system will fully cover your family's loss of income and any hospital and medication costs.
 - The amount you pay to reduce risk means that you will have less money left over to consume other products and services.
-

17. a) How much would you pay at the most per year to reduce your risk of *dying* by 10%?

Answer: _____ SEK per year

- b) From where would you take the money to pay for a reduction of the risk of dying? In other words, what things would you spend less on?

You may select more than one alternative.

- ☐ food
- ☐ entertainment, leisure activities, culture and TV
- ☐ alcohol and tobacco
- ☐ saving
- ☐ clothes and shoes
- ☐ residence, house appliances, furniture and decorating
- ☐ computer, cellular phone, etc.
- ☐ daily travel and vacation trips
- ☐ other, please specify _____

The following questions are about the risk of *dying* in a *traffic accident*

In an average year, the risk of *dying* in a *traffic accident* is 5 in 100,000 for individuals in their fifties.

-
18. How great do you think *your own risk* of *dying* in a *traffic accident* is in an average year? Your own risk may be higher or lower than the average. Consider how often you are or how much time you spend in traffic, which means of transportation you use, and how you behave in traffic, e.g. how safe a driver you are.

I think the risk is _____ in 100,000.

Now, we would like you to disregard completely what you would be willing to pay for increased safety, as covered in question 17, but concentrate only on the following:
In the following question, please answer how much you personally would be willing to pay for safety equipment that would reduce your risk of *dying* in a *traffic accident* by a 10%. Before you decide the maximum you would be willing to pay, we ask you to consider the following conditions:

- The risk reduction only applies to the risk of dying in a traffic accident. The risk of being injured in a traffic accident is not affected.
 - The safety equipment is not inconvenient, unattractive or uncomfortable to use. It is not noticeable at all. You are the only person who can use the equipment. Nobody else's risk factor is involved.
 - The safety equipment will only function for one year. You would subsequently have to renew payment if you wanted to continue to benefit from risk reduction.
 - An accident will not affect your family's finances, since it is assumed that the insurance system will fully cover your family's loss of income and any hospital and medication costs.
 - The amount you pay to reduce the risk means that you will have less money left over to consume other products and services.
-

19. How much would you pay at the most per year to reduce your risk of *dying* in a *traffic accident* by a 10%?

Answer: _____ SEK per year

The following question is about how you would use an increase in income

-
20. Imagine that you get a monthly increase in income of SEK 1000 after taxes next year. How would you distribute this increase in income? Distribute the SEK 1000 on the alternatives below. You do not need to use all the alternatives. When you add the amounts that you spend on the different alternatives, it should equal SEK 1000.

_____ SEK on food

_____ SEK on entertainment, leisure activities, culture and TV

_____ SEK on alcohol and tobacco

_____ SEK on saving

_____ SEK on clothes and shoes

_____ SEK on home ownership/rent, household appliances, furniture and interior decoration

_____ SEK on safety equipment, e.g. life jacket, helmet, fire extinguisher, winter tires

_____ SEK on preventive health care, exercise, dental care, etc.

_____ SEK on computer, cellular phone, etc.

_____ SEK on daily travel and vacation trips

_____ SEK on a new car

_____ SEK on other things, please specify _____

CONCLUDING QUESTIONS

21. What kind of car/cars does your household own?

	Car # 1	Car # 2	Car # 3
Make and model:			
Year of manufacture:			
Equipment in the car:	<input type="checkbox"/> ABS brakes <input type="checkbox"/> Airbag <input type="checkbox"/> Neither	<input type="checkbox"/> ABS brakes <input type="checkbox"/> Airbag <input type="checkbox"/> Neither	<input type="checkbox"/> ABS brakes <input type="checkbox"/> Airbag <input type="checkbox"/> Neither

22. What is your level of education?

- ☐ Grades 1 – 8 (Elementary and Middle School) or the equivalent
☐ High School (9-12) or the equivalent
☐ College, University or the equivalent
☐ Other, please specify _____
-

23. What is your combined yearly **household** income (i.e. income from employment, pension and/or own business?) before taxes?

- ☐ SEK 0 – 79, 900
☐ SEK 80,000 – 159,999
☐ SEK 160,000 – 239,999
☐ SEK 240, 000 – 319,999
☐ SEK 320, 000 – 399, 999
☐ SEK 400,000 – 599,999
☐ SEK 600,000 or above
-

24. May we contact you by phone you if we need additional information about any of the answers in your questionnaire? If yes, please provide your telephone number (including area code) below.

My phone number: _____

THANK YOU FOR YOUR HELP!

Gerking et al. questionnaire

Job Safety In The United States How Much Is Needed?



**A Nationwide Survey on an Important Issue
Facing Congress and the American People.**

**This questionnaire should be completed by the
principle wage-earner in your household.**

**INSTITUTE FOR POLICY RESEARCH
University of Wyoming
Laramie, Wyoming 82070**

ABOUT YOUR JOB

Q-1 First, we would like to ask a few questions about the work you do. In 1983 were you: (Please circle the number of your answer)

- 1 EMPLOYED PART-TIME
- 2 EMPLOYED FULL-TIME
- 3 RETIRED
- 4 UNEMPLOYED

Inasmuch as the questions we need to ask only concern people's 1983 job, it won't be necessary for you to complete the rest of the questions. However, we would greatly appreciate your checking this box ☐ and returning the questionnaire so we can take your name off of the mailing list. Many thanks for your cooperation. We greatly appreciate it.

Q-2 Please describe your main job or position in 1983 (if you had more than one job in 1983 we only need to know about your main job).

TITLE OF JOB OR POSITION: _____

NATURE OF THE WORK YOU DO: _____

IN WHAT KIND OF BUSINESS OR INDUSTRY IS YOUR WORKPLACE: _____

Q-3 Which one of the following occupational categories most closely reflects the type of work you do in your job? A few examples are given to help you decide. (Please circle the number of your answer)

- 1 SERVICE WORKER (Food service workers, Cleaning service workers, Dental assistants, Policemen)
- 2 LABORER (Longshoremen, Construction workers, Loggers, Garbage collectors)
- 3 TRANSPORTATION OPERATOR (Bus drivers, Taxicab drivers, Truck drivers, Railroad switch operators)
- 4 EQUIPMENT OPERATOR . . . (Textile workers, Drillers, Photographic processors, Smelters)
- 5 CRAFT WORKER (Carpenters, Machinists, Bakers, Tailors, Repairmen, Mechanics)
- 6 CLERICAL WORKER (Cashiers, Tellers, Secretaries, Receptionists, Telephone operators, Dispatchers)
- 7 SALES WORKER (Advertising agents, Real estate agents, Sales clerks, Sales representatives, Vendors)
- 8 MANAGER OR ADMINISTRATOR (Bank officers, Purchasing agents, Restaurant managers, School administrators)
- 9 PROFESSIONAL OR TECHNICAL (Accountants, Engineers, Physicians, Teachers, Entertainers)
- 10 FARMWORKER (Farmers, Farm laborers, Farm supervisors)

HOW SAFE IS YOUR JOB

2

Q-4 Some people face a high risk of injury and death from accidents on the job and others face a very low risk. Compared to most other jobs, do you feel your main job in 1983 was: (Please circle the number of your answer)

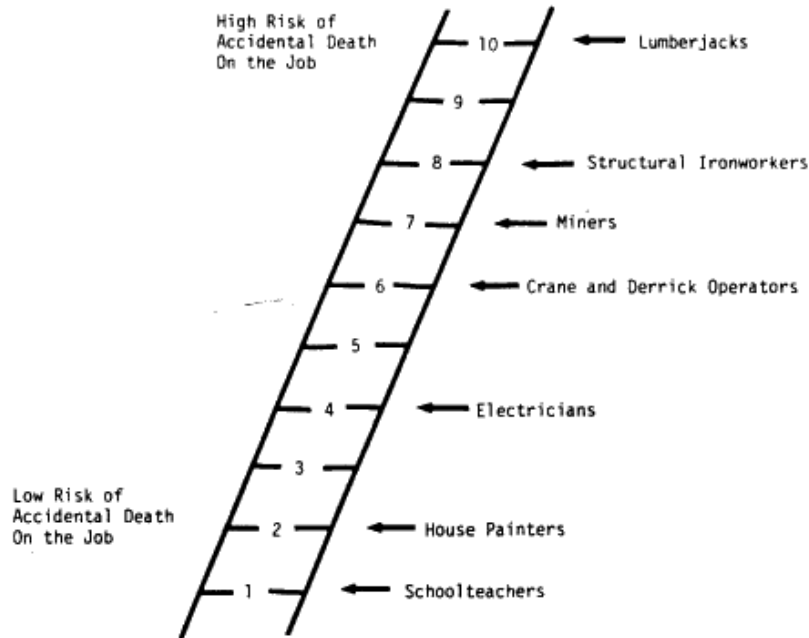
- 1 MUCH SAFER
- 2 SOMEWHAT SAFER
- 3 ABOUT AVERAGE
- 4 SOMEWHAT RISKIER
- 5 MUCH RISKIER

Q-5 Below are listed the major causes of how people die on the job. Depending on your particular job, some causes are not very likely to happen to you while others are more likely to happen. On a scale from 1 (could never happen) to 5 (most likely to happen), please circle the number which best indicates your feelings towards the chances of dying on a job like yours, as compared to other jobs, from each of the causes.

MAJOR CAUSES OF ACCIDENTAL DEATH AT WORK	Please circle one number for each cause				
	COULD NEVER HAPPEN				MOST LIKELY TO HAPPEN
A. On the road motor vehicle accident	1	2	3	4	5
B. A fall	1	2	3	4	5
C. Heart attack	1	2	3	4	5
D. Getting hit by industrial vehicle or equipment	1	2	3	4	5
E. Getting hit by object other than vehicle or equipment	1	2	3	4	5
F. Caught in, under or between objects other than vehicle or equipment	1	2	3	4	5
G. Electrocution	1	2	3	4	5
H. Gun shot	1	2	3	4	5
I. Airplane crash	1	2	3	4	5
J. Fire	1	2	3	4	5
K. Plant machinery operation	1	2	3	4	5
L. Explosion	1	2	3	4	5
M. Gas inhalation	1	2	3	4	5

JOB RELATED RISK

The ladder below shows levels of job-related accidental risk of death. Each step shows the number of deaths per year for every 4,000 people in an occupation. The higher on the ladder, the more accidental "on the job" deaths there are each year for that occupation. A few example occupations are given and they are placed on the ladder according to their actual levels of risk. Note that schoolteachers have about one death per 4,000 workers and lumberjacks have about 10 deaths per 4,000 workers each year. Of course, your 1983 job does have a level of risk somewhere on the ladder even if it has not been listed as one of the examples. Questions 6 and 7 refer to this ladder.



7-6 Now, please think about your main job in 1983 for a minute. In your opinion, which step on the ladder comes closest to describing the risk of accidental death in your job. (Please circle the step number of your answer)

STEP 10
STEP 9
STEP 8
STEP 7
STEP 6
STEP 5
STEP 4
STEP 3
STEP 2
STEP 1

(IF you picked STEP 10)

Just suppose the actual risk of accidental death in your job was Step 9 (meaning 9 out of every 4,000 workers in this job die each year). What is the smallest increase in annual gross (i.e., before deductions and taxes) income from your job that you would have to be paid in order to accept an increase in the risk of accidental death from Step 9 up to Step 10 (i.e., one more death per year for every 4,000 workers)? (Please circle the number)

- | | |
|------------|-----------------------|
| 1 (\$ 0) | 20 (\$ 380) |
| 2 (\$ 20) | 21 (\$ 400) |
| 3 (\$ 40) | 22 (\$ 420) |
| 4 (\$ 60) | 23 (\$ 440) |
| 5 (\$ 80) | 24 (\$ 460) |
| 6 (\$100) | 25 (\$ 480) |
| 7 (\$120) | 26 (\$ 500) |
| 8 (\$140) | 27 (\$ 600) |
| 9 (\$160) | 28 (\$ 700) |
| 10 (\$180) | 29 (\$ 800) |
| 11 (\$200) | 30 (\$ 900) |
| 12 (\$220) | 31 (\$1000) |
| 13 (\$240) | 32 (\$2000) |
| 14 (\$260) | 33 (\$3000) |
| 15 (\$280) | 34 (\$4000) |
| 16 (\$300) | 35 (\$5000) |
| 17 (\$320) | 36 (\$6000) |
| 18 (\$340) | 37 (More than \$6000) |
| 19 (\$360) | |

(IF you picked a step from 1 to 9)

Consider a situation in which you were asked to face more risk on your job. What is the smallest increase in annual gross (i.e., before deductions and taxes) income from your job that you would have to be paid in order to accept an increase in the risk of accidental death by one step (i.e., one more death per year for every 4,000 workers)? (Please circle the number)

- | | |
|------------|-----------------------|
| 1 (\$ 0) | 20 (\$ 380) |
| 2 (\$ 20) | 21 (\$ 400) |
| 3 (\$ 40) | 22 (\$ 420) |
| 4 (\$ 60) | 23 (\$ 440) |
| 5 (\$ 80) | 24 (\$ 460) |
| 6 (\$100) | 25 (\$ 480) |
| 7 (\$120) | 26 (\$ 500) |
| 8 (\$140) | 27 (\$ 600) |
| 9 (\$160) | 28 (\$ 700) |
| 10 (\$180) | 29 (\$ 800) |
| 11 (\$200) | 30 (\$ 900) |
| 12 (\$220) | 31 (\$1000) |
| 13 (\$240) | 32 (\$2000) |
| 14 (\$260) | 33 (\$3000) |
| 15 (\$280) | 34 (\$4000) |
| 16 (\$300) | 35 (\$5000) |
| 17 (\$320) | 36 (\$6000) |
| 18 (\$340) | 37 (More than \$6000) |
| 19 (\$360) | |

Q-7 In this question several different jobs are listed (A through O). Each of the jobs are identical to your 1983 job except that their risk and salary levels are different than your 1983 job. The risk level for each job is one of the steps on the ladder (see page 3). The salary for each job is your 1983 salary, plus or minus some percentage of that salary. On a scale from 1 (much worse job) to 10 (much better job), please circle the number which best indicates your opinion of how each job would compare to your 1983 job. Thus, a job with risk level 1 and twice your 1983 salary might get a high number. A job with risk level 10 and half your 1983 salary might get a low number. Also, a job that you feel would be just as good as your 1983 job would get a 5. Please circle one number for each job.

			Circle one for each job										
JOB	RISK LEVEL	SALARY COMPARED TO 1983	MUCH WORSE JOB					YOUR 1983 JOB					MUCH BETTER JOB
			1	2	3	4	5	6	7	8	9		
A.	Step 2	10% more . . .	1	2	3	4	5	6	7	8	9		
B.	Step 7	5% less . . .	1	2	3	4	5	6	7	8	9		
C.	Step 3	the same . . .	1	2	3	4	5	6	7	8	9		
D.	Step 9	10% less . . .	1	2	3	4	5	6	7	8	9		
E.	Step 1	10% less . . .	1	2	3	4	5	6	7	8	9		
F.	Step 4	5% more . . .	1	2	3	4	5	6	7	8	9		
G.	Step 5	10% less . . .	1	2	3	4	5	6	7	8	9		
H.	Step 8	the same . . .	1	2	3	4	5	6	7	8	9		
I.	Step 6	10% more . . .	1	2	3	4	5	6	7	8	9		
J.	Step 4	5% less . . .	1	2	3	4	5	6	7	8	9		
K.	Step 10	the same . . .	1	2	3	4	5	6	7	8	9		
L.	Step 5	the same . . .	1	2	3	4	5	6	7	8	9		
M.	Step 7	5% more . . .	1	2	3	4	5	6	7	8	9		
N.	Step 9	10% more . . .	1	2	3	4	5	6	7	8	9		
O.	Step 2	10% less . . .	1	2	3	4	5	6	7	8	9		

MORE ABOUT YOUR JOB

6

Q-8 How much formal education is required to get a job like your 1983 job?
(Please circle the number)

- 1 0- 8 GRADES
- 2 6- 9 GRADES; FINISH GRADE SCHOOL
- 3 9-11 GRADES; SOME HIGH SCHOOL
- 4 12 GRADES; FINISH HIGH SCHOOL
- 5 SOME COLLEGE, NO DEGREE NECESSARY
- 6 COLLEGE DEGREE; BA OR BS
- 7 SOME GRADUATE WORK
- 8 ADVANCED COLLEGE DEGREE OR PROFESSIONAL DEGREE

Q-9 Do you have to have some work experience or special training to get a job like your 1983 job? (Please circle the number)

- 1 YES
- 2 NO

If YES, what kind of experience or special training is that?
(Please circle the number)

- 1 APPRENTICESHIP
- 2 VOCATIONAL TRADE SCHOOL
- 3 ON-THE-JOB TRAINING
- 4 WORK EXPERIENCE FROM ANOTHER JOB
- 5 OTHER (Please specify) _____

Q-10 On a job like your 1983 job, how long would it take the average new person to become fully trained and qualified?

_____ YEARS OR _____ MONTHS (IF LESS THAN A YEAR)

Q-11 How long have you worked for your present employer?

_____ YEARS OR _____ MONTHS (IF LESS THAN A YEAR)

Q-12 How long have you done the type of work you do?

_____ YEARS OR _____ MONTHS (IF LESS THAN A YEAR)

Q-13 Do you have any physical or nervous condition that limits the type of work or the amount of work you can do in your job? (Please circle the number)

- 1 YES
- 2 NO

Q-14 Do you have any physical or nervous condition that would limit the type of work or the amount of work you could do in another job you would like? (Please circle the number)

- 1 YES
- 2 NO

Q-15 In 1983, did you work for yourself? (Please circle the number)

- 1 YES
2 NO →

If NO, then did you work for the Federal, state or local government? (Please circle the number)

- 1 YES
2 NO

Q-16 Did you supervise the work of other employees, or tell them what to do? (Please circle the number)

- 1 YES →
2 NO

If YES, then did you have any say about their pay or promotion? (Please circle the number)

- 1 YES, ALL OF THEM
2 YES, SOME OF THEM
3 NO, NONE OF THEM

About how many people did you supervise?

_____ PEOPLE

Q-17 Approximately how many people are employed where you work?

_____ NUMBER OF PEOPLE

Q-18 Is your job covered by a union contract? (Please circle the number)

- 1 YES →
2 NO

If YES, do you belong to that union? (Please circle the number)

- 1 YES
2 NO

Q-19 How many weeks did you actually work on your job in 1983?

_____ WEEKS

Q-20 On the average, how many hours a week did you work on your job in 1983?

_____ HOURS

Q-21 Did you have any overtime which is not included in that? (Please circle the number)

- 1 YES →
2 NO

If YES, then how many hours did that overtime amount to in 1983?

_____ HOURS

ABOUT YOU

8

Q-22 What is your age?

_____ YEARS

Q-23 What is your sex? (Please circle the number)

- 1 MALE
- 2 FEMALE

Q-24 What is your race? (Please circle the number)

- 1 BLACK
- 2 ORIENTAL
- 3 HISPANIC OR PERSON OF MEXICAN DESCENT
- 4 WHITE
- 5 OTHER (Please specify) _____

Q-25 How much formal education have you completed? (Please circle the number)

- 1 0- 5 GRADES
- 2 6- 8 GRADES; FINISHED GRADE SCHOOL
- 3 9-11 GRADES; SOME HIGH SCHOOL
- 4 12 GRADES; FINISHED HIGH SCHOOL
- 5 TRADE SCHOOL
- 6 SOME COLLEGE
- 7 COLLEGE DEGREE; BA OR BS
- 8 SOME GRADUATE WORK
- 9 ADVANCED COLLEGE DEGREE OR PROFESSIONAL DEGREE

Q-26 In what type of area do you live? (Please circle the number)

- 1 RURAL
- 2 SUBURBAN
- 3 CENTRAL CITY

Q-27 Have you moved in the last three years? (Please circle the number)

- 1 YES
- 2 NO

Q-28 About how many miles is your job from where you live?

_____ MILES

Q-29 On the average, how long does it take to travel from your home to your job?

_____ HOUR OR _____ MINUTES (IF LESS THAN AN HOUR)

Q-30 In what type of area is your job located? (Please circle the number)

- 1 RURAL
- 2 SUBURBAN
- 3 CENTRAL CITY

Q-31 How many years have you been employed since you were 18?

YEARS

Q-32 How many of these years were you employed full time for most of the year?

YEARS

Q-33 In general, how satisfied were you with your main job in 1983? (Please circle the number)

- 1 VERY SATISFIED
- 2 SATISFIED
- 3 NEUTRAL
- 4 DISSATISFIED
- 5 VERY DISSATISFIED

Q-34 Are you a veteran? (Please circle the number)

- 1 YES
- 2 NO

Q-35 Of the total fringe benefit package paid by your employer of your job in 1983 (e.g., workman's compensation, pension plan payments, health insurance payments, etc.), approximately what percentage of your gross annual earnings was this package worth? (Please circle the number)

- 1 0%-10%
- 2 11%-20%
- 3 21%-30%
- 4 31%-40%
- 5 41%-50%
- 6 DON'T KNOW

Q-36 Approximately what percentage of your total income received in 1983 was made up of government assistance payments (e.g., welfare, social security, veterans benefits, unemployment compensation, etc.)? (Please circle the number)

- 1 0%
- 2 1%-10%
- 3 11%-20%
- 4 21%-30%
- 5 31%-40%
- 6 41%-50%
- 7 51%-60%
- 8 61%-70%
- 9 71%-80%
- 10 81%-90%
- 11 91%-100%

Q-37 How were you paid in your 1983 job? (Please circle one number)

- 1 SALARY
- 2 HOURLY WAGE
- 3 OTHER

(IF Other) How were you paid on your job in 1983? (Please circle the number)

- 1 PIECE WORK
- 2 COMMISSION ONLY
- 3 COMMISSION AND SALARY
- 4 TIPS ONLY
- 5 TIPS AND SALARY
- 6 OTHER (Please specify) _____

How much was the annual gross (i.e., before deductions and taxes) income you received from your main job in 1983?

\$ _____

If you worked more hours than average during some week, did you get paid for those extra hours? (Please circle the number)

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 YES 2 NO | <p>(IF Yes) About how much would you make, per hour, for that overtime?</p> <p>\$ _____ PER HOUR</p> |
|---|--|

(IF Hourly) What was your hourly wage rate on your job for your regular or "straight" work time in 1983?

\$ _____ PER HOUR

What was your hourly wage rate on your job for your overtime in 1983?

\$ _____ PER HOUR

(IF Salary) How much was your annual gross (i.e., before deductions and taxes) income you received from your job in 1983?

\$ _____

If you worked more hours than average during some week, did you get paid extra for those extra hours? (Please circle the number)

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 YES 2 NO | <p>(IF Yes) About how much did you make, per hour, for that overtime?</p> <p>\$ _____ PER HOUR</p> |
|---|--|

Is there anything we may have overlooked? Please use this space for any additional comments you would like to make about the need for on-the-job safety in the United States.

Your contribution to this effort is very greatly appreciated. If you would like a summary of results, please print your name and address on the back of the return envelope (NOT on this questionnaire). We will see that you receive it.

Respondent No.			Industry No.			

Hello, my name is Carmen Pedro, a graduate student in Economics at the Hautes Études Commerciales. Today, I will be asking you some questions on the value you give to safety. The answers that you will provide will be used to complete my thesis. Your cooperation would be greatly appreciated and please rest assured that all answers are strictly confidential. Please read the questionnaire carefully.

MAIN QUESTIONNAIRE

Brief Explanation (This is a fictitious example)

The probability of a bus passenger being killed in a road accident is 1 in 10 000 per year. This means that out of 10 000 passengers, 1 will die in a road accident this year.

The probability of a motorcyclist being killed in a road accident is 8 in 10 000 per year. This means that out of 10 000 motorcyclists, 8 will die in a road accident this year.

Therefore, a motorcyclist has a greater probability of dying in a road accident than a bus passenger.

- 1A. Imagine that you have to buy a new car. You have chosen a model which you find satisfactory. The salesperson informs you that for an additional amount you can have air bags installed which inflate automatically in case of a collision reducing your risk of injury. These inflatable air bags reduce your personal risk of death in car accident from 4 in 10 000 to 2 in 10 000. Your risk level is therefore reduced in half.

What amount would you be willing to pay to have inflatable air bags installed in your car. The cost of inflatable air bags is the same regardless of the type of car (compact, sportive, luxurious, etc.). Please bear in mind how much you can afford.

_____ ENTER IN AMOUNT, YOU WOULD BE
WILLING TO PAY TO HAVE YOUR
PERSONAL RISK REDUCED FROM
4 IN 10 000 TO 2 IN 10 000

IF YOU HAVE ANY COMMENTS PLEASE INSCRIBE THEM BELOW.

- 1B. Imagine that the only model of the car that you desire is equipped with inflatable air bags. The salesperson informs you that the price of the car can be reduced if the air bags are removed. What reduction in price must you be offered before you accept to have the inflatable air bags removed?

_____ ENTER IN AMOUNT

IF YOU HAVE ANY COMMENTS PLEASE INSCRIBE THEM BELOW.

2. Below you will find a list of 10 major causes of injury at work. For each cause, I would like you to rate the likelihood of each occurring to you at work on a scale of 1 to 5.

"1" Could never happen
 "2" Could rarely happen
 "3" Could possibly happen
 "4" Likely to happen
 "5" Most likely to happen

In each case, please **CIRCLE** the number which best applies.

		<u>Could never</u>	<u>Could rarely</u>	<u>Could possibly</u>	<u>Likely to</u>	<u>Most likely to</u>
1.	Fall from elevation	1	2	3	4	5
2.	Caught in, under or between object	1	2	3	4	5
3.	Motor vehicle accident	1	2	3	4	5
4.	Fall (not from elevation)	1	2	3	4	5
5.	Physical overexertion	1	2	3	4	5
6.	Electrocution	1	2	3	4	5
7.	Bodily reactions (allergies, headaches... due to work substances or improper ventilation)	1	2	3	4	5
8.	Exposure to extreme temperatures	1	2	3	4	5
9.	Struck by/against an object	1	2	3	4	5
10.	Exposure to radiation, toxic and noxious substances	1	2	3	4	5

3. Below you will find a ladder defining the risk level of certain occupations, I would like you to circle the step number that most closely describes your risk of a job-related accidental death.

High Risk of Accidental Death on the Job	- 10 -	← Dynamiter in a mine
	- 9 -	← Firefighter
	- 8 -	← Metal worker (iron, steel, etc.)
	- 7 -	← Worker in production of chemical products
	- 6 -	← Truck driver
	- 5 -	← Lumberjack
	- 4 -	← Electrician
	- 3 -	← Driver-salesman
	- 2 -	← Teller & Cashier
Low Risk of Accidental Death on the Job	- 1 -	← Secretary

4A. IF CIRCLED "10" AT QUESTION 3, PLEASE GO TO QUESTION 4B.

How much more per week, before taxes, would you require to voluntarily work at the same job if the risk of accidental death was instead one step higher on the ladder?

_____ ENTER IN ADDITIONAL AMOUNT
PER WEEK, BEFORE TAXES

IF YOU HAVE ANY COMMENTS PLEASE INSCRIBE THEM BELOW.

IF YOU ANSWERED QUESTION 4A, PLEASE GO TO QUESTION 5A.

4B. Suppose initially you were on the 9th step, how much per week, before taxes, would you require to voluntarily work at the same job if the risk of accidental death was instead one step higher on the ladder, i.e., how much would you require to move from the 9th step to the 10th step?

_____ ENTER IN ADDITIONAL AMOUNT
PER WEEK, BEFORE TAXES

IF YOU HAVE ANY COMMENTS PLEASE INSCRIBE THEM BELOW.

5A. IF CIRCLED "1" AT QUESTION 3, PLEASE GO TO QUESTION 5B.

How much of a decrease per week, before taxes, would you willingly forego to work at the same job if the risk of accidental death was instead one step lower on the ladder?

_____ ENTER IN AMOUNT PER WEEK,
BEFORE TAXES, THAT YOU
WOULD WILLINGLY FOREGO

IF YOU HAVE ANY COMMENTS PLEASE INSCRIBE THEM BELOW.

IF YOU ANSWERED QUESTION 5A, PLEASE GO TO QUESTION 6.

- 5B. Suppose you were initially on the 2nd step, how much of a decrease per week, before taxes, would you willingly forego to work at the same job if the risk of accidental death was instead one step lower on the ladder; i.e., how much would you willingly forego to move from the 2nd step to the 1st step?

_____ ENTER IN AMOUNT PER WEEK,
BEFORE TAXES, THAT YOU
WOULD WILLINGLY FOREGO

IF YOU HAVE ANY COMMENTS PLEASE INSCRIBE THEM BELOW.

6. The probability of being killed on the job as a firefighter, a relatively dangerous job, is approximately 5.8 in 10 000, per year.

The probability of being killed on the job as an office worker, a relatively safe job, is approximately .057 in 10 000, per year, which is 102 times lower than the probability of being killed on the job as a firefighter.

With this in mind, what do you think is your risk of being killed on the job per year? Please take into consideration that if your job requires that you travel, excluding transportation to and from work, this may constitute an element of risk.

_____ ENTER IN YOUR RISK OF BEING
KILLED ON THE JOB PER YEAR

6

- 7A. Suppose now, that you are a construction worker for the city of Montreal. Your risk of being killed on the job in a given year is 2 in 10 000. This means that out of 10 000 construction workers for the City, 2 will die on the job this year. You have been offered a job with a private construction company. Your work hours, fringe benefits and everything else will be equal, except that you will be exposed to more dangerous working conditions, for example working on higher buildings. Your risk of being killed on the job is now 4 in 10 000 in a given year. This is twice the risk of the job with the city of Montreal. How much more will you have to be paid, before taxes, per week, before you accept this job?

_____ ENTER IN ADDITIONAL AMOUNT
PER WEEK, BEFORE TAXES

IF YOU HAVE ANY COMMENTS PLEASE INSCRIBE THEM BELOW.

- 7B. Suppose now, you are a production worker in a chemical company in Montreal. Your risk of being exposed to radiation leading to an incurable disease in a given year is 2 in 10 000. This means that out of 10 000 chemical workers, 2 will contract an incurable disease this year. You have been offered a job with another company. Your work hours, fringe benefits and everything else will be equal, except that you will be working in more dangerous conditions; for example, with older equipment. Your risk of being exposed to radiation leading to an incurable disease in a given year is now 4 in 10 000. This is twice the risk of the previous job. How much more will you have to be paid, before taxes, per week, before you accept this job?

_____ ENTER IN ADDITIONAL AMOUNT
PER WEEK, BEFORE TAXES

IF YOU HAVE ANY COMMENTS PLEASE INSCRIBE THEM BELOW.

8. How many work days last year, if any, have you missed due to illness or injury related to your job?

_____ ENTER IN NUMBER OF DAYS

Please pardon the delicate nature of this next question.

9. Have you or any family member (close friend) ever been severely injured, sick or killed due to a job-related accident? «Severely injured or sick» in this case means a permanent disability, hospitalization, a loss of a limb, etc.

YES.....1

NO.....2

10. Is your car equipped with inflatable air bags?

YES.....1

NO.....2

Finally, so that I may classify the information you have given me, I would like to ask you some questions about yourself. Please let me remind you, again, that all answers are strictly confidential.

11. . In your present employment do you work?

FULL-TIME.....1

OR PART-TIME.....2

12. How many hours per week do you work on average?

_____ ENTER NUMBER OF HOURS

13. What is your total weekly wage before taxes?

_____ ENTER IN YOUR WEEKLY
WAGE BEFORE TAXES

14. What is your occupation? NOT where you work, just the type of job that you perform.

8

15. How long have you been employed at this occupation? Please also include in your answer, the number of years employed in other firms working in this occupation.

_____ ENTER IN NUMBER OF YEARS

16. Are you unionized?

YES.....1

NO.....2

17. How long have you been employed with this establishment?

_____ ENTER IN NUMBER OF YEARS

18. In your present job, are you a supervisor?

YES.....1 → GO TO QUESTION 19

NO.....2 → GO TO QUESTION 20

19. How many people do you supervise?

_____ ENTER IN NUMBER OF PEOPLE

20. Are you married or living with someone, as a married couple?

YES.....1 → GO TO QUESTION 21

NO.....2 → GO TO QUESTION 22

21. Does your spouse work outside the home?

YES.....1

NO.....2

22. How many dependents do you have?

_____ ENTER IN NUMBER OF DEPENDENTS

23. What level of formal education did you reach?

	<u>REACHED</u>	<u>GRADUATED</u>
Elementary	1	2
Secondary or high school	3	4
Community College, CEGEP, or Vocational School	5	6
University: Undergraduate school	7	8
University: Postgraduate school	9	10
No formal schooling	11	

24. Could you please tell me how old you are?

_____ ENTER IN AGE

25. Please circle your sex:

MALE.....1
FEMALE.....2

26. Is there anything else that you would like to add that we have not covered? For instance, did you have any difficulties answering any of the questions. If yes which questions and why.

Optional:

Name _____

Telephone _____

Thank you very much for your cooperation.

Appendix C.

Comments on selected questionnaires.

Corso et al questionnaire

This questionnaire was administered over the telephone, but the respondent had been previously sent written survey materials (i.e., this was a phone-mail-phone survey).

The respondent is first asked quality of life questions, then the first of 6 modules begins. The six modules (=sections) are on unrelated causes of deaths or of contracting certain diseases, and risk reductions are considered separately in each of these modules. Only the responses to the WTP questions collected as part of section four are analyzed in Corso et al. (2001), and we are not aware of other peer-reviewed articles based on this questionnaire at this time.

The **first section** is dedicated to longevity lottery questions. The **second questions** introduces the concept of prevention and treatment, and the **third section** applies it to the hypothetical situation where the respondent is traveling to a foreign country and exposing himself to the risk of contracting a foodborne illness. The concept of compound probability is used, because the respondent is first told about the probability of contracting the disease, and then of dying, assuming that the disease is contracted in the first place.

Double-bounded dichotomous choice questions are asked about (i) a preventive treatment that would reduce the risk of contracting and hence dying of the foodborne illness from 4 in 100,000 to 2 in 100,000 (a 50% reduction, which is pointed out to the respondent), and a (ii) treatment that would reduce the same risk by the same amount, assuming that the illness is contracted. The respondent is told that he would be seen by an American doctor and treated in an American clinic with American medication. If the respondent declines to pay, follow-up questions inquire about the reasons why.

The **fourth section** is about auto safety. The responses collected through this section are those analyzed in Corso et al. (2001). This section starts with questions about use and beliefs about the effectiveness of airbags. The respondent is told that the average baseline risk of dying in a car accident is X in 10,000 every year. (Slightly different wording is used in describing this risk, depending on which visual aid treatment the respondent is assigned to.) This is followed by questions asking the respondent how concerned he is about this risk, and whether he thinks that his own risk is higher, lower, or the same as the average.

The risk reduction would be delivered by a side-impact airbag, which would reduce the risk of dying from 2 in 10,000 (2.5 in 10,000 in split samples) to 1.5 in 10,000. Clearly, the risk reduction is varied to the respondent, and can take one of two possible values (1 or 0.5 in 10,000.) The risk reduction is also translated into “community comparison” (i.e., how many people out of the residents of a small town).

The payment vehicle for the risk reduction is an increase in the car payments per year over 5 years. The elicitation format is double-bounded dichotomous choice.

In **section five**, respondents are asked to consider blood safety in the hypothetical situation that they need a transfusion during elective surgery to reduce chest pains (a painful but not a life threatening situation). They are told that the risk of blood infected with the hepatitis virus is 3 in 10,000 while the risk of blood infected with the HIV virus is 4 in a million. This section focuses on the risk of contracting the disease, but not on the risk of dying (respondents are told that hepatitis is rarely fatal, whereas HIV is, although people live normal lives for 10 years or more before experiencing severe symptoms).

Respondents are then asked questions about their WTP for a screening exam that would reduce the risk of hepatitis alone, HIV alone, or both (split samples). It should be noted that the risks of exposure to the different type of virus is shown in the same visual aid, so that the 3 in 10000 is converted into 300 in a million, and later the respondent is explicitly told about this risk being 300 in a million.

Section six of the questionnaire focuses on (a) a risk reduction or (b) extension in life expectancy to be experienced at age 60 (70—split sample for this age as well as for (a) and (b)), and begins with providing the respondent the chance for a person of his age and gender to survive to age 60 (70).

It describes a pneumonia vaccine that would (a) extend remaining life expectancy at age 60 (70) from 21 (14) years to 21 years and 11 months (14 years and 5 months), or (b) reduce the risk of dying at age 60 from 4.8% in that year to 4.6% in that year. One of the two versions of this questions, therefore, is similar to that of Johannesson and Johansson (1996), although the latter focuses on a life expectancy extension at age 75 and is not specific about the type of the medical intervention that would raise the remaining life expectancy.

Clearly, this is a rather long questionnaire with many risk reductions, baseline risks and risk reductions of different magnitude. One wonders about possible confusion on the part of the respondent and the ability to stay focused through this phone interview. It should be pointed out that the risk reduction and WTP responses analyzed in Corso et al. refer to section 4 of the questionnaire.

- **Mode of administration of the survey.** Phone-mail-phone.
- **Does the questionnaire use visuals to explain risks and risk reductions?** Yes, in some of the split samples, and the visual aids vary across respondents (one of the purposes of the study was to test visual aids and their effects on scope).
- **What is the type of graphical representation (pie chart, grid, risk ladder, etc.) and is the quality of the graphical representation acceptable?** No aid, linear scale, log scale, dots, with the scale always providing a community comparison or a comparable risk. I find the risk scales distracting—busy and with information overload that might detract attention from the magnitude of the risks.

- **Were respondents asked to report subjective baseline risks?** Only in a qualitative fashion. For example, after being told that the risk of dying in a car accident is X in 10,000, they are asked whether they think that their own risk is higher or lower.
- **Subjective or objective risk reduction?** objective.
- **If the baseline risk was assigned to the respondent by the questionnaire, was the risk gender-specific? Age-specific? Location-specific? Occupation-specific?** No, only random variation as per randomized treatment.
- **What context does the risk refer to? Transportation risk? Workplace risks? Risks associated with a particular health condition (e.g., diabetes or hypertension)? Generic/abstract risks?** Foodborne illness, auto accident, blood transfusion.
- **What was the order of magnitude of the risks?** Varies—ranging from X in a million to X in 10,000. There is also X in 100,000.
- **Was risk referred to over a number of years?** No, risks are generally expressed on a per year basis.
- **What was the smallest and largest baseline risk, and what was the percentage risk reduction?** The smallest is 4 in a million, largest is 3 in 10,000. Percentage risk reductions can be as high as 50%.
- **In the WTP question, was the risk reduction delivered by a private or public mechanism?** Private (air bags, medical treatment, blood screening test, pneumonia vaccine).
- **Was the payment for the risk reduction supposed to take place over a number of years, or was it a one-time payment?** Varies. In the auto safety question, for example, people were asked to consider increased car payment per year over 5 years, whereas paying for medical tests or treatment is on a one-time basis.
- **What was the elicitation method?** Dichotomous choice with dichotomous choice follow-up (resulting in double-bounded analysis).
- **WTA or WTP?** WTP.
- **Are respondents allowed to change/revise their responses to the WTP questions?** No
- **Are respondents asked questions about how certain they feel about their responses to the WTP questions?** Yes
- **Are respondents tested for probability comprehension?** No
- **Are respondents tested for whether they accept the baseline risks (if the baseline risks are objectively assigned to the respondent by the researcher)?** Yes, by asking qualitative questions at least for the auto risk question (do you think your own risk is higher, the same, or lower than...).
- **Are respondents asked about risk-reducing or risk-loving behaviors that might explain their acceptance of baseline risks and/or their responses to the WTP questions?** In the case of the auto safety questions, they are asked if they have air bags in their own car, and if they think them to be effective.
- **Are respondents asked debriefing questions to understand their acceptance of the risk reducing mechanism and scenario?** Some, such as whether they

thought that the medication would be effective in treating or preventing foodborne illnesses.

- **What kind of information about family status, other sociodemographics, etc are the respondents asked?** Not shown in the partial questionnaire I have

Does the questionnaire ask about respondent health? How? General quality of life question.

Johannesson and Johansson (1996) questionnaire.

This is a telephone survey.

The questionnaire has virtually the same structure and questions as the instrument used by Johannesson et al., except for the commodity to be valued, and for the fact that the quality of life question is dropped. The questionnaire opens with telling people that for a person of their gender and age, the “chance of reaching the age of at least 75 is X percent.” The very next sentence states that a 75-year-old lives an average of 10 more years.

The commodity to be valued is explained immediately thereafter, and it is not a risk reduction, but a life expectancy increase: “Consider the following possibility. If you survive to the age of 75, you will have an opportunity to receive a new medical treatment. It is estimated that this will increase your remaining years of life by one year, i.e., to about 11 years. Would you buy the treatment if it costs X kronor and had to be paid for this year?”

As before, people are not offered any verbal analogies to help them digest the concept of chance and think of remaining lifetimes. They are also not asked about their current health, so there is no way of telling whether the chance of making to age 75 was accepted by the respondent. Moreover, it is surprising that people were told about a new medical treatment, but were given no details about approval by the Ministry of Health, about payments being out of pocket or co-pays under the national health care system, etc.

- **Mode of administration of the survey:** telephone.
- **Does the questionnaire use visuals to explain risks and risk reductions?** No
- **Type of graphical representation (pie chart, grid, risk ladder, etc.):** N/A
- **Is the quality of the graphical representation acceptable?** N/A
- **Does the questionnaire use verbal analogies to explain risks and risk reductions?** No
- **Were respondents asked to report subjective baseline risks?** No
- **Subjective or objective risk reduction?** No
- **If the baseline risk was assigned to the respondent by the questionnaire, was the risk gender-specific? Age-specific? Location-specific? Occupation-specific?** The chance of surviving to age 75 was age- and gender-specific, but the extension in remaining life expectancy at age 75 was the same for everyone (one year).
- **What context does the risk refer to? Transportation risk? Workplace risks? Risks associated with a particular health condition (e.g., diabetes or hypertension)? Generic/abstract risks?** All causes of death, although these are not mentioned, but the risk reduction would be from a medical intervention. No specific context is provided.

- **Were people given the comparison with the risks of dying from other causes?** No
- **What was the order of magnitude of the risks?** The chance of surviving to age 75 was expressed as, e.g., “75 percent.”
- **Was risk over a number of years?** N/A
- **What was the smallest and largest baseline risk, and what was the percentage risk reduction?** N/A
- **Is the risk reduction delivered by a private or public mechanism?** life expectancy extension is a private good
- **Was the payment for the risk reduction supposed to take place over a number of years, or was it a one-time payment?** One-time payment (now)
- **Elicitation method?** Dichotomous choice, single-bounded
- **WTA or WTP?** WTP
- **Are respondents allowed to revise their responses to the WTP questions?** No
- **Are respondents asked questions about how certain they feel about their responses to the WTP questions?** Yes, but only if they answer “yes” to the payment question, and the English translation suggests a vague question (“are you fairly or totally certain that you would buy” the treatment at the stated price?)
- **Are respondents tested for probability comprehension?** No
- **Are respondents tested for whether they accept the baseline risks (if the baseline risks are objectively assigned to the respondent by the researcher)?** No
- **Are respondents asked about risk-reducing or risk-loving behaviors that might explain their acceptance of baseline risks and/or their responses to the WTP questions?** No
- **Are respondents asked debriefing questions to understand their acceptance of the risk reducing mechanism and scenario?** No
- **What kind of information about family status, other sociodemographics, etc are the respondents asked?** Household size, marital status, education, income (personal and combined with their spouse), size of the city they live in, region of Sweden, urban v. non-urban. The year of birth is asked among the sociodemographics questions, but people must have been asked what age group they belong to in the screener part of the survey.
- **Does the questionnaire ask about respondent health? How?** No.

Johannesson et al. (1997) questionnaire

This is a telephone survey.

The interview starts with asking the respondent's age, and moves immediately to the heart of the matter. Respondents are given the risk reduction scenario and then asked a DC choice question about their WTP for it. Respondents are told that "It is estimated that roughly X men out of 10,000 your age will die in the next year. Imagine that you could receive a preventive and pain-free treatment that would reduce your risk of dying during the next year, but have no effects after that year. The treatment would lower your risk of dying in the next year from X to (X-2) in 10,000. Would you buy this treatment at present if it cost you XXX kronor?" (yes/no) Risks vary with age and gender.

If the respondent answered "yes," he was then queried whether he was "fairly certain" or "totally certain" that he would buy this treatment for the stated price.

Next, the respondent is asked to rate his quality of life on a scale from 1 (=worst imaginable condition) to 10 (=best imaginable condition).

This closes the portion of the survey dedicated to risks and/or health. The next question are about socio-demographics and include household size, marital status, education, income (monthly and pre-tax; both personal and combined with spouse), size of the city where the respondent lives, region, and urban v. non-urban area.

Clearly, this survey must have taken a very short time to complete. People are taken straight to the point, but are offered no analogies for them to digest the magnitude of the risks, etc. There is no debriefing about acceptance of the medical intervention that would deliver the risk reduction, nor about any other aspect of the survey. Also, respondents are not told what the main causes of death for people their age and gender are. There is no mention of auto fatalities, cardiovascular illnesses, etc.

The absolute risk reduction is the same for everyone (2 in 10,000), and the questionnaire only presents the absolute risk reduction, but the corresponding relative risk reductions range from 1 percent to 33 percent of the baseline risks.

Respondents are asked how they rate their quality on a scale from 1 to 10, but there are no questions about chronic illnesses or other ailments. Lacking such questions, it is impossible to say whether people accepted or may have questioned their risks of dying over the next year.

- **Mode of administration of the survey:** telephone.
- **Does the questionnaire use visuals to explain risks and risk reductions?** No
- **Type of graphical representation (pie chart, grid, risk ladder, etc.):** N/A
- **Is the quality of the graphical representation acceptable?** N/A

- Does the questionnaire use verbal analogies to explain risks and risk reductions? No
- Were respondents asked to report subjective baseline risks? No
- Subjective or objective risk reduction? Objective
- If the baseline risk was assigned to the respondent by the questionnaire, was the risk gender-specific? Age-specific? Location-specific? Occupation-specific? Age- and gender-specific.
- What context does the risk refer to? Transportation risk? Workplace risks? Risks associated with a particular health condition (e.g., diabetes or hypertension)? Generic/abstract risks? All causes of death, although these are not mentioned, but the risk reduction would be from a medical intervention. No specific context is provided.
- Were people given the comparison with the risks of dying from other causes? No
- What was the order of magnitude of the risks? X in 10,000 over the next year
- Was risk over a number of years? Annual risk
- What was the smallest and largest baseline risk, and what was the percentage risk reduction? 6 in 10,000 to a max of 200 in 100,000, and the percentage risk reduction ranges from 1 percent to 33 percent.
- Is the risk reduction delivered by a private or public mechanism? Private
- Was the payment for the risk reduction supposed to take place over a number of years, or was it a one-time payment? One-time payment, and the risk reduction is only over the next year.
- Elicitation method? Dichotomous choice, single-bounded
- WTA or WTP? WTP
- Are respondents allowed to revise their responses to the WTP questions? No
- Are respondents asked questions about how certain they feel about their responses to the WTP questions? Yes, but only if they answer “yes” to the payment question, and the English translation suggests a vague question (“are you fairly or totally certain that you would buy” the treatment at the stated price?)
- Are respondents tested for probability comprehension? No
- Are respondents tested for whether they accept the baseline risks (if the baseline risks are objectively assigned to the respondent by the researcher)? No
- Are respondents asked about risk-reducing or risk-loving behaviors that might explain their acceptance of baseline risks and/or their responses to the WTP questions? No
- Are respondents asked debriefing questions to understand their acceptance of the risk reducing mechanism and scenario? No
- What kind of information about family status, other sociodemographics, etc are the respondents asked? Household size, marital status, education, income (personal and combined with their spouse), size of the city they live in, region of Sweden, urban v. non-urban. Age is asked at the very beginning of the survey.
- Does the questionnaire ask about respondent health? How? No, but people are asked to rate their quality of life on a scale from 1 to 10.

Lanoie et al. (1995) questionnaire

This is an in-person survey, although the paper suggests that some questionnaires may have been mailed to respondents.

In the paper, Lanoie et al. state that they wish to conduct a study similar to that of Gerking et al. (1988), but their risk ladder shows risks that are within the range of those facing the respondents.

The questionnaire opens with a simple probability tutorial based on the road transport context. The risks are of the order of X per 10,000 in a year.

In the second question, respondents are asked to imagine that they have to buy a car, and that airbags could be installed to reduce the risk of injury in an accident. They are told that the airbags would reduce the risks of dying from 4 to 2 in 10,000 (but they are not reminded that this is an annual figure). The question reminds them that this is 50% risk reduction, queries them about how much they would pay for the airbags.

It seems to me that providing the relative risk equivalent of the absolute risk reduction is a very good idea. The authors demonstrate care in writing out the survey instrument by also proving a reminder of the budget constraint.

The third question re-phrases the previous one in terms of WTA to have the airbags removed.

After this exercise and valuation questions, which refer to the road transportation context, the survey instrument moves to workplace risks. It guides the respondent to considering different types of workplace accidents (ranging from “fall from elevation” to “bodily reactions” and “exposure to radiation, toxic and noxious substances”) asking them to rate them as events that “could never happen,” “could rarely happen” etc. up to “most likely to happen.”

Next, the respondents are shown a risk ladder, with steps from 1 to 10, that gives examples of the type of occupation corresponding to the each of the steps. The lowest possible risk is that of secretaries, while the highest possible risk is that of a dynamiter in a mine.

Respondents are asked both a WTA question to go up the risk ladder by one step, and a WTP question to go down the risk ladder by one step. For people that were already at the top and at the bottom of the ladder, respectively, Lanoie et al use Gerking et al’s approach of asking them to imagine being one step lower and higher, respectively.

After the WTA and WTP questions, respondents are told that a firefighter faces a risk of dying of 5.8 in 10,000 a year, while an office worker faces a risk of 0.057 in 10,000. This is in contrast with the risk ladder, where no quantitative information about the risk was provided.). People are then asked to estimate their own risk of dying. Even in this question, the authors take care of explaining that the risk of office workers is 102 times lower than that of a firefighter, and of reminding the respondent that travel and transportation to and from work may be an element of risk.

In the next page, page 6, people are asked once again a question about WTA for a change of risk of 2 in 10000, just like in the auto and airbag question, but this time the context has changed, as the respondents are to imagine being a construction worker in the city of Montreal. This is question 7A. In question 7B, people are asked to report their WTA for an increase in risk of 2 in 10,000. The context has been changed again, since the respondent is asked to imagine being a production worker in a chemical plant in Montreal. Also, the risk comes from exposure to radiation, which results in an “incurable disease.” (This may mean cancer, or leukemia, and the associated morbidity and suffering, plus dread, may influence WTP and make it different from that for a reduction in risk in the worker’s own occupation.)

Questions 8 and 9 ask about the number of days that the respondent has had to take off from work for sickness or injuries, and about any workplace sicknesses or injuries experienced by other family members (or close friends).

Since questions 8 and 9, and question 11 and the following, are about work and workplace risks, question 10, which asks whether the respondent’s car is equipped with airbags, seems out of place.

Questions 11-19 are about wages, hours worked, experience with the company and nature of work. They appear a bit more streamlined than in the Gerking et al. questionnaire. Questions 20-25 are about marital status, whether they spouse works, number of dependents, education, age and gender.

- **Mode of administration of the survey:** in person (some could have been sent to the respondents).
- **Does the questionnaire use visuals to explain risks and risk reductions?** Not to explain risks, but to elicit perceived riskiness of the job. This is the same risk ladder as in Gerking et al. (1988), but with revised occupations.
- **Type of graphical representation (pie chart, grid, risk ladder, etc.):** risk ladder
- **Is the quality of the graphical representation acceptable?** Very simple
- **Does the questionnaire use verbal analogies to explain risks and risk reductions?** It uses a probability tutorial, but not analogies that might help the respondent process the size of the risk. The tutorial refers to the transportation safety context. Respondents are told that the probability of being killed in a road accident is, for example, 8 in 10000 per year for a motorcyclist. “This means that

out of 10,000 motorcyclists, 8 will die in a road accident this year.” Repsondents are not told how to imagine 10,000 (e.g., a small town), or 8 out of 10000.

- **Were respondents asked to report subjective baseline risks?** Yes, in two places. First, they are asked to pinpoint their own job on a risk ladder. Second, after the valuation questions for their own occupations, they are asked to estimate subjective risks, after being told the risk figures for firefighters and office workers.
- **Subjective or objective risk reduction?** The main WTA/WTP refer to one step up/down the ladder. Analysis treats this as an objective risk reduction. In addition, there are four more valuation questions: WTA and WTP for risk change in the transportation safety question (2), WTA for 2 in 10000 risk change if the respondent was a construction worker, and WTA for 2 in 10000 risk change if the respondent was a production worker at a chemical plant. WTP and WTA for the airbags could be treated as a warm-up question or analyzed on its own. WTA as a construction and plant worker should be treated differently, since the latter refers to radiation exposure that results in an incurable illness, and not in a workplace accident.
- **If the baseline risk was assigned to the respondent by the questionnaire, was the risk gender-specific? Age-specific? Location-specific? Occupation-specific?** N/A
- **What context does the risk refer to? Transportation risk? Workplace risks? Risks associated with a particular health condition (e.g., diabetes or hypertension)? Generic/abstract risks?** Two questions on transportation risks, two questions on risk at one’s job, two questions on risks in different occupations.
- **Were people given the comparison with the risks of dying from other causes?** No
- **What was the order of magnitude of the risks?** When shown to the respondent, they are X in 10,000.
- **Was risk over a number of years?** Annual risks
- **What was the smallest and largest baseline risk, and what was the percentage risk reduction?** when stating a risk reduction to the respondent, the instrument uses a baseline of 4 in 10000, and a risk reduction of 2 in 10000, emphasizing that this is 50% reduction.
- **Is the risk reduction delivered by a private or public mechanism?** private
- **Was the payment for the risk reduction supposed to take place over a number of years, or was it a one-time payment?** Sacrifice or increase in income per week. This is a bit of a discrepancy, since risks are expressed on an annual basis. But if the workers are paid weekly, this may be a more natural way to think. No testing to make sure that the respondents converted WTP or WTA to annual basis was done.
- **Elicitation method?** Open-ended
- **WTA or WTP?** WTA and WTP
- **Are respondents allowed to revise their responses to the WTP questions?** No
- **Are respondents asked questions about how certain they feel about their responses to the WTP questions?** No.
- **Are respondents tested for probability comprehension?** No

- **Are respondents tested for whether they accept the baseline risks (if the baseline risks are objectively assigned to the respondent by the researcher)?** No, but they are asked what they think their current baseline risk is, and in four of the valuation questions they are asked to imagine that their risks would be X.
- **Are respondents asked about risk-reducing or risk-loving behaviors that might explain their acceptance of baseline risks and/or their responses to the WTP questions?** Yes, if they have airbags in their cars.
- **Are respondents asked debriefing questions to understand their acceptance of the risk reducing mechanism and scenario?** No
- **What kind of information about family status, other sociodemographics, etc are the respondents asked?** Number of dependents, marital status, education, wage rate, whether spouse works, age, gender, other occupation characteristics, including union status.
- **Does the questionnaire ask about respondent health? How?** No, but it asks how many days the respondent has taken off from work for sickness or injury.

Gerking et al. questionnaire

- * This questionnaire was administered by mail.
 - * It opens with questions about the respondent occupation status, job title, type of occupation and industry.
 - * The second page of the questionnaire tackles the issue of perceived safety at work. The respondent is first asked to rate the safety of his or her job on a scale from 1 to 5, where 1 means “much safer” than the average and 5 means “much riskier” than the average.
- The respondent is then shown a matrix with a list of possible accidental causes of death at work, including motor vehicle accidents, explosion, gas inhalation, electrocution, gun shot, being hit by industrial machinery or caught between machines (no mention of exposure to radiation or substances that would cause long term health damage), and is asked to rate them on a scale from 1 to 5, where 1 means “could never happen” and 5 means “most likely to happen.”
- * The following page shows a risk ladder. Respondents are told that for the profession at the bottom of the ladder (schoolteacher) the annual risk of dying on the job is 1 in 4000, whereas for the profession at the top of the ladder (lumberjack) the risk of dying in a year is 10 in 4000. Each step is, therefore, implied to mean a 1 in 4000 change in the risk of dying.
- In the subsequent page, the respondent is asked to indicate which step of the ladder he thinks his risk is, and to pinpoint on a payment card his WTP (WTA) for a step down (up) on the ladder. Those respondents who picked the bottom (top) of the ladder are instructed to consider a movement from the next step downward (upward).
- * Additional information about the tradeoffs between income and risks are elicited on the next page, where the respondent is shown a matrix with various combination of risk ladder step levels and percentage changes relative to current wages. The respondent is to indicate on a non-point Likert scale whether the stated situation is worse, about the same as, or better than his current situation. In the Likert scale, 1 indicates “much worse” than the current situation, and 9 means “much better” than the current situation. (It should be noted that the responses to these questions are analyzed in a separate paper, and not in Gerking et al. (1988)).
 - * page 6 of the questionnaire elicits information about the respondent’s current job, education and experience. One interesting question is whether the respondent suffers from physical or nervous conditions that limit the type of work that they can do.
 - * the subsequent pages asks about individual characteristics of the respondent, including age, race, gender, urban/suburban/rural environmental where he lives; plus

past employment, job satisfaction, fringe benefits, transfer payments received; and how the respondent is paid at his current job (salary, by the hour, by the piece, on commission, etc.), and total income.

- **Mode of administration of the survey:** mail survey
- **Does the questionnaire use visuals to explain risks and risk reductions?** Risk ladder
- **What is the type of graphical representation (pie chart, grid, risk ladder, etc.) and is the quality of the graphical representation acceptable?** Risk ladder, with added annotation about lowest risks and highest risks. Quantitative information about the change in risk implied by each step of the ladder is in writing above the ladder.
- **Were respondents ask to report subjective baseline risks?** Yes, pinpoint a step on the ladder
- **Subjective or objective risk reduction?** objective—one in 4000 (move one step on the ladder)
- **If the baseline risk was assigned to the respondent by the questionnaire, was the risk gender-specific? Age-specific? Location-specific? Occupation-specific?** n/a
- **What context does the risk refer to? Transportation risk? Workplace risks? Risks associated with a particular health condition (e.g., diabetes or hypertension)? Generic/abstract risks?** Workplace risks.
- **What was the order of magnitude of the risks?** Baseline risks: from 1 to 10 in 4000 per year. Risk reduction is by 1 in 4000 per year.
- **Was risk referred to over a number of years?** Over one year.
- **What was the smallest and largest baseline risk, and what was the percentage risk reduction?** baseline ranges from 1 to 10 in 4000, and the change is by 1 in 4000, implying relative changes of 10% to 100%.
- **In the WTP question, was the risk reduction delivered by a private or public mechanism?** no mention was made of the risk reduction mechanism, but it would be presumably private.
- **Was the payment for the risk reduction supposed to take place over a number of years, or was it a one-time payment?** Income sacrifice or increase per year.
- **What was the elicitation method? Open-ended? Dichotomous Choice? If dichotomous choice, was it single-bounded or double-bounded?** Payment card used, so technically speaking it would be on a interval-data basis. However, the paper treats it as open-ended except for the extreme amounts on the payment card.
- **WTA or WTP?** Either WTP or WTA, in split samples.
- **Are respondents allowed to change/revise their responses to the WTP questions?** No.

- **Are respondents asked questions about how certain they feel about their responses to the WTP questions?** No.
- **Are respondents tested for probability comprehension?** No.
- **Are respondents tested for whether they accept the baseline risks (if the baseline risks are objectively assigned to the respondent by the researcher)?** No, but the baseline risk is subjective.
- **Are respondents asked about risk-reducing or risk-loving behaviors that might explain their acceptance of baseline risks and/or their responses to the WTP questions?** No.
- **Are respondents asked debriefing questions to understand their acceptance of the risk reducing mechanism and scenario?** No.
- **What kind of information about family status, other sociodemographics, etc are the respondents asked?** Age, gender, race, income, if moved recently, education.
- **Does the questionnaire ask about respondent health? How?** The questionnaire asks whether the respondent has a physical or nervous condition that affects the type of work they can do.

Appendix D.

The following reports are available for download using the links provided:

Gegax, D., S. Gerking and W. Schulze et al. (1985). "Valuing Safety: Two Approaches," in *Experimental Methods for Assessing Environmental Benefits, Volume IV*. Report prepared for the U.S. EPA, Office of Policy Analysis under Assistance Agreement #CR811077-01.

Link:

<http://yosemite.epa.gov/EE/epa/erm.nsf/vwRepNumLookup/EE-0280E?OpenDocument>

Viscusi, W.K., W.A. Magat and J. Huber (1991). *Issues in Valuing Health Risks: Applications of Contingent Valuation and Conjoint Measurement to Nerve Diseases and Lymphoma*. Draft report to EPA, Office of Policy, Planning and Evaluation under Assistance Agreement CR# 815455-01-1 and 814388-02.

Link:

<http://yosemite.epa.gov/EE/epa/erm.nsf/vwRepNumLookup/EE-0223?OpenDocument>

Full text reports for the following references can be obtained by contacting Anna Alberini (aalberini@arec.umd.edu) or Nathalie Simon (simon.nathalie@epa.gov):

Miller, Ted, and Jagadish Guria, "The Value of Statistical Life in New Zealand: Market Research on Road Safety, January 30, 1991.

Miller Ted, and Jagadish Guria, "Valuing Family Members' Statistical Lives,"